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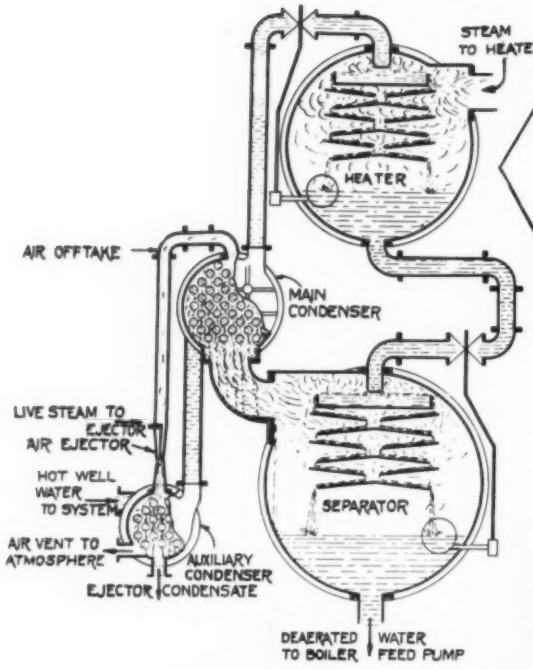
DEAERATION

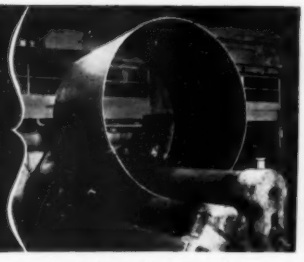


THE FIRST DEAERATOR, DEVELOPED AND BUILT BY ELLIOTT IN 1918

After much research and experimentation in the virgin field of processing feedwater for the removal of oxygen, Elliott engineers in 1918 developed, built and sold the first practical commercial deaerating unit. By 1924 the supreme value of the achievement was recognized in the award to W. S. Elliott of the Edward Longstreth medal by the Franklin Institute, Philadelphia . . . With this commanding lead, backed by valuable pioneering experience, Elliott engineers have continued to set the pace in deaeration development.

HOW ELLIOTT BUILDS DEAERATING HEATERS

All the work is done right in the Elliott shops. Rolling of shells, welding and fabricating of parts is all handled by Elliott personnel. It's actually custom tailoring in metal, for every unit is built to fit its job.



Rolling a fair-sized shell.

ASME-approved automatic welding is used wherever possible.

ELLIOTT Company

DEAERATOR AND HEATER DEPARTMENT

N2-2

has come a long way!

1952 THE ELLIOTT DEAERATING HEATER OF TODAY

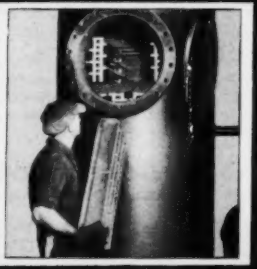
The modern Elliott deaerating heater combines the three stages of the deaerating process—heating, deaerating and venting—within a single shell, thus eliminating headroom problems and simplifying construction. The tubular vent condenser is replaced by a spray pipe and vent hood, both of stainless steel, which perform the functions of the clumsy, outmoded vent condenser with no maintenance other than occasional inspection. Here in itself is a major saving.

The entire heating section, and in fact all parts in contact with corrosive water, are of stainless steel. Trays, too, are of stainless steel—not only corrosion-free, but far lighter in weight—another factor for lower maintenance.

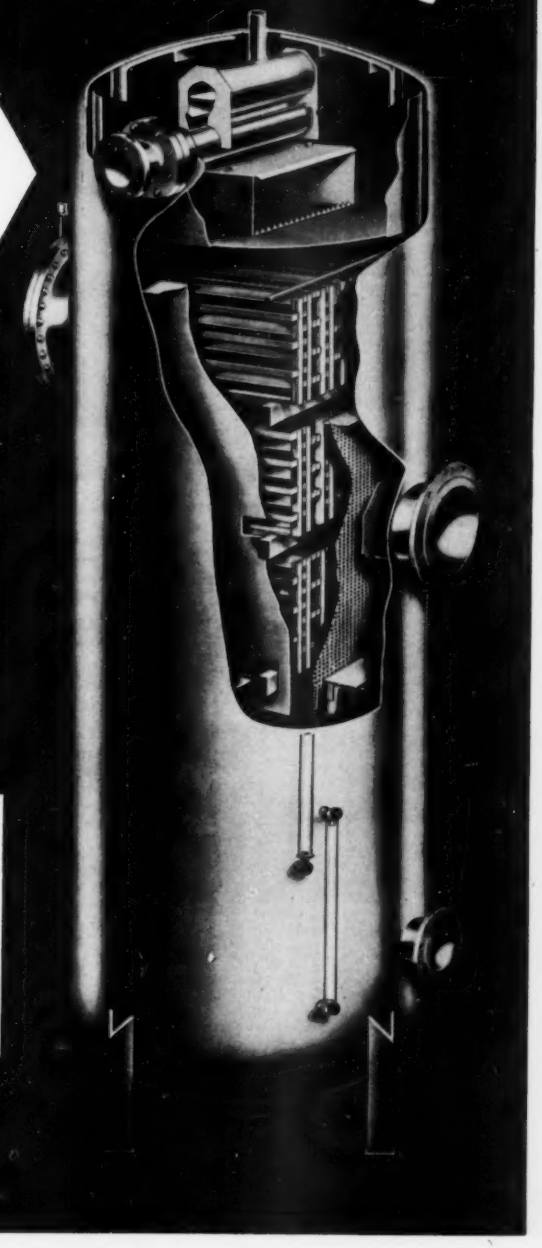
The picture at right shows the tray-type unit. The Elliott spray-type unit, developed largely for marine use, is also available.

For full details on Elliott deaerating heaters contact your local Elliott representative or write Elliott Company, Jeannette, Pa.

Tack-welding a baffle-plate in place before final welding.



Stainless steel trays are no burden at all in manual handling.



For more data circle 501 on Post Card

THE most carefully calculated installation of steam-heated processing equipment will fail to deliver full output if the steam traps do not have adequate condensate and air handling capacity. When this happens an important part of the capital investment in plant and equipment is wasted.

After you have figured the amount of steam that will be condensed, you need data on:

Condensate Capacity—not theoretical, not estimated, not cold water, but actual test findings with traps discharging condensate at steam temperature.

Trap Capacity Safety Factors, or ratio between continuous discharge capacity and actual amount of condensate to be handled. These may run from a low of 2 to 1 or as high as 8 to 1. Armstrong data tells you just what safety factor to use to obtain adequate air venting capacity and maximum heat transfer.

Armstrong trap data helps you get traps "big enough" for the job, but not too big; assures you maximum operating efficiency; eliminates corrections after installation. For traps and trapping assistance call your local Armstrong Representative, or write:

ARMSTRONG MACHINE WORKS
810 Maple Street, Three Rivers, Michigan

HERE'S AN EXAMPLE of the reliability of Armstrong data: Armstrong trap capacity figures are based on hundreds of tests with condensate at steam temperature. The choking effect of flash steam through the orifice as well as the back pressure created by flash steam were automatically taken into account. Actual hookups were used to allow for the effect of pipe friction.

If the capacity ratings had been based on cold water tests, which produce no flash steam they would be too high. Orifice test ratings are too high because they ignore the effect of pipe friction. Slide rule calculations of trap capacities have never been corrective.

When you use Armstrong Data and specify Armstrong traps you know that you are getting the right trap for the job.

SEND FOR the new 44-page Steam Trap Book—including 14 pages of data on how to size Traps for nearly every type of equipment. Free on request—no obligation.

ARMSTRONG STEAM TRAPS

For more data circle 502 on Post Card

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NOVEMBER 1952
VOL. 56 • NO. 11

Industrial spider web—Workman applying finishing touches to maze of steel boiler tubes

Power Engineering

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The only magazine devoted exclusively to the job interests of power engineers

MATHIESON CHEMICAL CORPORATION'S new plant at Doe Run, Kentucky, engineered and constructed by BADGER Process Division, Stone & Webster Engineering Corporation.

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ENGINEERS' PREVIEW

ANNOUNCEMENT that Charles W. Hammond will be head of the Mechanical Engineering Department for Walter Kidde Nuclear Laboratories has been made.

In his new capacity, Mr. Hammond will be responsible for mechanical design and engineering work performed by Walter Kidde Nuclear Laboratories, an organization which engages in research, development and engineering for the design of nuclear power plants and the application of nuclear technology to industrial problems.

★ ★ ★

A NEW CONDENSED COURSE in Business Practice and Management, designed especially for engineers and other specialized executives who find themselves in need of broader training in general business administration, has been announced by the International Correspondence Schools of Scranton, Penn.

According to John C. Villaume, acting dean of the faculty at I. C. S., the 20 lessons which comprise the course are chosen to give the engineer, technician, or professional man a good understanding of principles, practices and management.

The course includes lessons on the Economics of Business, Forms of Business Organization, and Office Management; Commercial Law; Financing of Business, Accounting for Executives and Internal Auditing; Personnel Organization, Organized Training and Collective Bargaining; Report Writing; and concludes with a section of Marketing, consisting of lessons on Sales Analysis, Advertising Letters, and Advertising Research and Testing.

Average study time required for completion of the course is estimated at 350 hours. It is available, Dean Villaume says, both to individual students and to employers who wish to provide specific training for key personnel.

★ ★ ★

A FELLOWSHIP FUND to help promising young engineers and scientists of the Westinghouse Electric Corporation continue their studies at a graduate level has been established in honor of the late Leon R. Ludwig, outstanding inventor and Westinghouse engineering executive.

Announcement of the educational trust was made by A. C. Monteith, Westinghouse vice-president in charge of engineering, who also is a member of the Fellowship Committee which will administer the Fund.

Mr. Ludwig joined the Westinghouse graduate student training course following his graduation in 1925 and rose rapidly through the Company's engineering ranks. He was the first manager of that major Westinghouse plant. He was transferred from Buffalo to Company headquarters in Pittsburgh in 1950 as staff assistant to the vice-president in charge of industrial products.

To be eligible for a Fellowship, a candidate must have shown marked ability in engineering or scientific fields and must be a Westinghouse employee of at least two years' service.

★ ★ ★

APPOINTMENT OF FREDERICK S. MALLETTE, assistant director of research in charge of air-pollution control activities, American Steel and Wire Division, United States Steel Company, as full-time executive secretary of the committee on air-pollution controls of the American Society of Mechanical Engineers, has been announced by T. E. Purcell, general superintendent, power stations, Duquesne Light Co., Pittsburgh, chairman of the committee. Mr. Mallette's duties will be to co-ordinate and expedite the committee's program of co-operation and collaboration with other organizations.

The committee, formed in 1949 with the approval of the Engineers Joint Council, is composed of 24 representatives of many organizations having a substantial interest in this field. Its chief objectives are to initiate and co-ordinate research concerning the health, comfort, nuisance, engineering, and economic aspects of air-pollution; to collaborate in the formulation and publication of standards of appropriate nature; and to encourage and assist in the preparation, presentation, and publication of papers on the many phases of atmospheric pollution.

★ ★ ★

ANDREW W. KRAMER, Editor of POWER ENGINEERING, has been appointed a member of the United States Atomic Energy Commission Advisory Committee on Technological Information. This we regard as a great honor to Mr. Kramer, as well as to POWER ENGINEERING, and as a well-deserved recognition of Mr. Kramer's standing in the field of engineering interpretation of the whole atomic energy picture.

This Committee on Technological Information is a permanent committee superseding a former *ad hoc* committee that was established in 1949 to assist the Commission in making available unclassified and declassified technical information developed in the nation's atomic energy facilities that might be useful to American industry. This Committee's findings and recommendations have aided the Commission so much that it is now being made a permanent committee. At the same time it has been augmented by the addition of several members and in view of the importance of the field POWER ENGINEERING represents, recommendations were made to include Kramer in the Committee. Official invitation to join the Committee came from M. W. Boyer, General Manager of the Atomic Energy Commission.

It will be remembered that Kramer was one of several technical magazine editors who were members of the press group observing the tests of the atomic bomb at Bikini in 1946. All the other members of the press represented newspapers or general magazines.

Andrew W. Kramer, Editor, POWER ENGINEERING, shortly after his return from Bikini in 1946, shown here preparing one of his famous articles on the engineering and peaceful uses of atomic energy

In a series of dramatic dispatches, published in POWER ENGINEERING monthly during the tests, Kramer interpreted for engineers the outstanding scientific and technical facts of this great development. Following that, he produced articles explaining the various technical and engineering phases of the atomic energy development as they became available, emphasizing particularly the phases most important in the development of power and interpreting them in a way engineers can understand. Publication of these articles in POWER ENGINEERING, through 1946 and 1947 and their continuation in a separate magazine, *Atomics*, for a year or so after that, attracted wide attention in the field. Combined with this, Kramer gave many interpretative lectures to non-technical groups on the subject of atomic energy and is still being called upon to give such lectures.

All these activities, in a field that is fast approaching practical reality in the development of atomic energy power plants, have led up to this latest appointment.

ALUMINUM COMPANY OF AMERICA (ALCOA) will undertake the construction of a 400-million-dollar aluminum smelting project in Alaska as soon as the necessary land can be purchased and government approvals obtained. This ALCOA-Alaska project would initially be capable of producing 200,000 tons of aluminum annually.

The Alaskan smelting facilities and electric power developments necessary to operate them would be situated in the Taiya Valley district, near Skagway, Alaska. Financing of the project would be done entirely with private capital.

Approximately ten kilowatt hours of electricity are consumed in the production of a single pound of aluminum.

Hydroelectric power for the proposed Taiya project will be generated by damming the Yukon River at Miles Canyon, near Whitehorse.

Water from the reservoir thus formed would be carried under the Rocky Mountains through two tunnels having a combined length of approximately 21 miles, to two ALCOA power houses in the Taiya Valley area.

★ ★ ★

A NEW and highly accurate method of using atomic energy to detect and measure impurities in foods, pharmaceuticals, metals, and other materials, has been developed by Union Carbide scientists at Oak Ridge National Laboratory.

Dr. C. E. Larson, director of the Laboratory, explained that the analysis technique involves placing the test sample in the Oak Ridge graphite reactor, or atomic furnace. The sample is thus exposed to neutron bombardment, and in this way the traces of impurities in the material are made artificially radioactive. Then, using the highly sensitive instruments and detectors developed at the Laboratory, the scientists can measure with great accuracy the exact quantities of impurities that may be present.

Anyone interested in learning more about neutron-activation analysis should write to Carbide and Carbon Chemicals Company, Oak Ridge National Laboratory, P. O. Box "P", Oak Ridge, Tennessee, Attention: Radioisotope Control Department. The Laboratory will furnish information as to how samples may be submitted and whether any particular analysis can be made with the new technique.

★ ★ ★

A SUBMARINE CABLE linking the United Kingdom and France will enable British plants to operate on power fed from French hydroelectric installations in the Alps.

Plans for an interchange of power by cable are now being worked out by French and British technical experts.

Britain's steam-operated power plants would export energy to France during the summer, when drought cuts water supplies for hydroelectric operations. In the winter, the electrical tide would be reversed, and French Alpine power would help save British coal.

First cross-Channel pilot link will consist of four lead-covered single-core cables, operating at 132,000 volts, with gas pressure to maintain insulation.

The British and French power systems are roughly similar in size. In Britain, the capacity available totals 14,200,000 kw from steam generating plants plus 185,000 kw from hydro power.

France already has 2-way power connections with Belgium, Luxemburg, Germany, Italy, Switzerland and Spain.

★ ★ ★

THE AIR POLLUTION and Smoke Prevention Association of America, Inc., which has been suffering from *hyperonomatomekia* for more than two years, finally did something about it.

It has been bedevilled by the length of its name, and changed it to Air Pollution Control Association.

The change was announced by Robert T. Griebling, Executive Secretary, who served on the Tellers' Committee which counted the letter ballots sent to members following the annual meeting at Cleveland in June, when the change was first proposed.

The orginal name taken by the air purification group in 1907 was Smoke Prevention Association. This was changed in Montreal in 1950 to the longer name to indicate the greater diversification of activity in the association. But it was far too long.

"We are getting to be known as men of letters, although we're not literary," Mr. Griebling said. "I couldn't write the name on hotel registers because it was too long. I compromised by signing 'Mellon Institute', where our offices were located and because I am a fellow there."

P. S. *Hyperonomatomekia* is plain Greek for plain English "unusually long name."

★ ★ ★

CONSTRUCTION OF FACILITIES related to the eventual development of nuclear propulsion for aircraft was authorized by the U. S. Atomic Energy Commission. Testing facilities will be built at the AEC's National Reactor Testing Station in Idaho.

The new facilities are estimated to cost approximately $33,000,000 and construction is scheduled to begin immediately.

Preliminary design studies for the AEC ground test station have been performed by the Parsons-Macco-Kiewit Company of Los Angeles, California, under a subcontract with General Electric.

The design, development and fabrication of the prototype aircraft propulsion reactor are being done by the Aircraft Gas Turbine Department of General Electric at Lockland, Ohio. The nuclear phases of the project parallel the associated nonnuclear devices being developed by General Electric under an Air Force contract.

Design and construction of the ground test facilities will be administered by the AEC's Idaho Operations Office. The Chicago Operations Office will continue to have responsibility for the reactor development contract with General Electric. Support in nuclear design and development also is being furnished by the Oak Ridge National Laboratory.

★ ★ ★

J. H. MCCULLOUGH has been promoted to Power Production Manager of the Texas Division of The Dow Chemical Company in Freeport, Texas.

Dow's power facilities include two plants, and a new high-pressure outdoor plant is scheduled to go into operation in November. Dow has the largest industrial power operation in Texas and one of the largest in the United States.

J. H. McCullough, new Power Production Manager of the Texas Division of The Dow Chemical Co.

Mr. McCullough joined Dow in February 1951, as staff assistant to Texas Division Assistant General Manager N. D. Griswold. He is a director of the Texas Water Conservation Association, a member of the American Society of Mechanical Engineers, and a professional engineer, state of Texas.

He was associated with the Interlake Iron Corp. of Chicago from 1926 to 1934 and with Carbide and Carbon Chemicals from 1934 to 1951 in Whiting, Ind., South Charleston, W. Va., and Texas City, Texas.

★ ★ ★

THE AMERICAN SOCIETY OF CIVIL ENGINEERS will elect five outstanding leaders in the engineering profession in their respective countries to honorary membership, the Society's highest distinction. Two from the United States and the other three from France, Canada and Brazil.

The honorary members, who will be inducted are: Ervin G. Bailey, New York; Harvey S. Mudd, Los Angeles; Andre L. J. Coyne, Paris; Chalmers J. Mackenzie, Saskatchewan and Ottawa, and Ary F. Torres, Sao Paulo.

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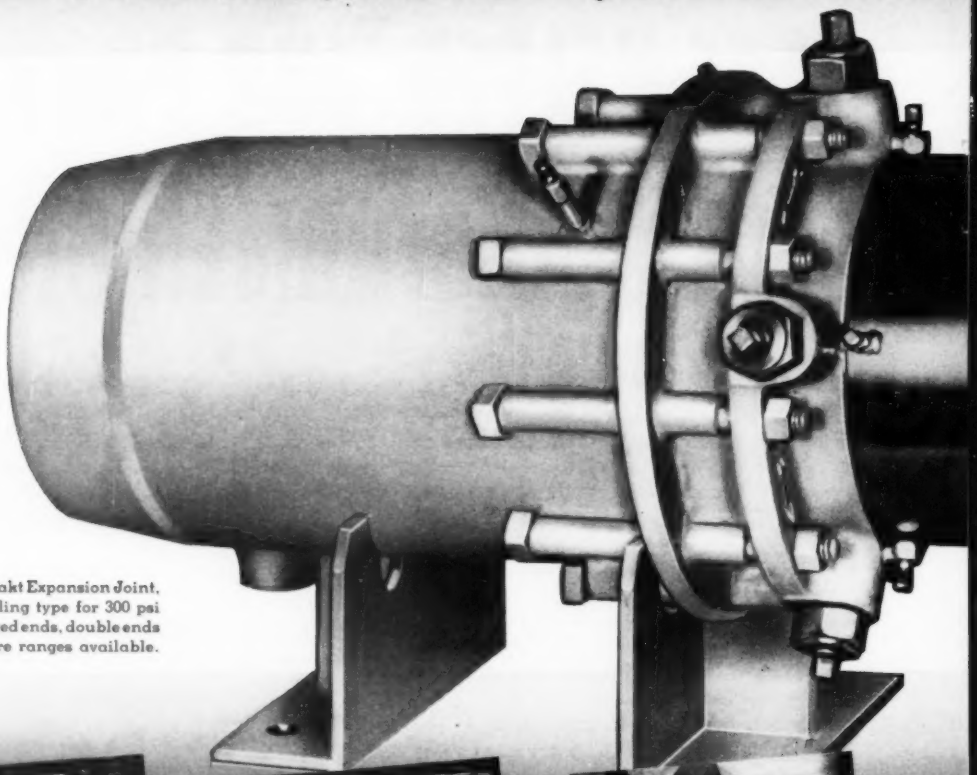
PHILADELPHIA ELECTRIC
GUN-PAKT EXPANSION JOINTS for



Yarway Gun-Pakt Expansion Joint, single end welding type for 300 psi pressure. Flanged ends, double ends and all pressure ranges available.

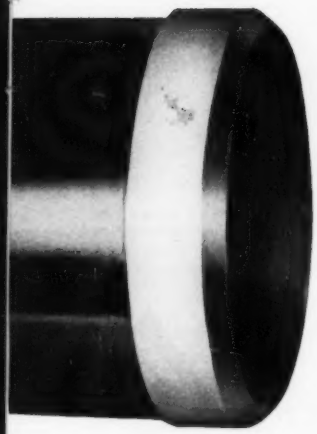
Boring body of 24" Gun-Pakt Joint for Philadelphia Electric Co. in Yarway factory.

Installing 24" Yarway Gun-Pakt Joint in Philadelphia Electric underground steam line.

Adding packing to Yarway Gun-Pakt Joint in P.E. manhole.

YARWAY®

relies on 24" UNDERGROUND STEAM LINE

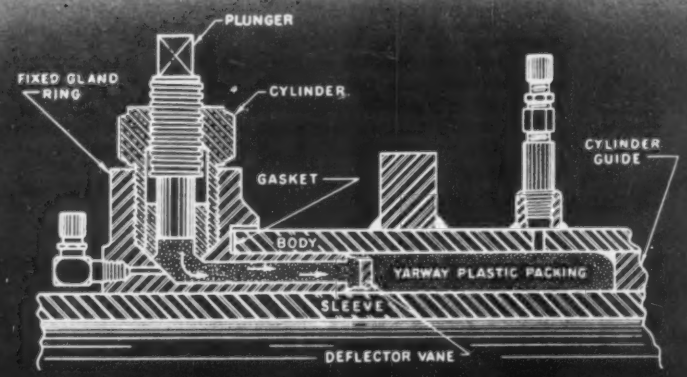


Philadelphia Electric Co. is one of many utilities, institutions and industrial plants who rely on Yarway Gun-Pakt Expansion Joints for steam distribution lines. As an example, twenty-four large 24" Gun-Pakt Joints are helping maintain PE's reputation for reliability, on their new 24" steam distribution line. Gun-Pakt Joints frequently are selected because of the following features.

- **HIGH FACTOR OF SAFETY.** Gun-Pakt Joints are rugged joints—strong and dependable.
- **LOW MAINTENANCE.** No need for shutdowns, because Gun-Pakt Joints are *serviced under full steam pressure.*
- **FEWER JOINTS NEEDED.** Each sliding sleeve may have a 4", 8", or 12" traverse—maximum expansion 24" for a double-end joint. Fewer needed in given length of line.

For the full story on these and other Gun-Pakt Expansion Joint features (like service outlets right on the joint) write for Yarway Catalog EJ-1912.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities



CROSS SECTION OF GUN-PAKT FEATURE

To add packing, you simply insert a plug of Yarway packing, twist a wrench, and the joint is tight, the job done . . . while *joint is under pressure.*

GUN-PAKT EXPANSION JOINT

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Automobile
Breweries
Building Materials
Carpet
Cellophane
Cement
Chemical
Coal Mining
Coke
Cold Storage
Dairy
Department Stores
Distilling
Explosives
Electrical Equipment
Electric Power
Food Products
Foundries
Gas Works
Gelatine
Glass
Hosiery
Knitting Mills
Institutions
Laundries
Leather
Linoleum
Locomotive
Lumber
Machinery
Metal Producing
Mining
Municipal
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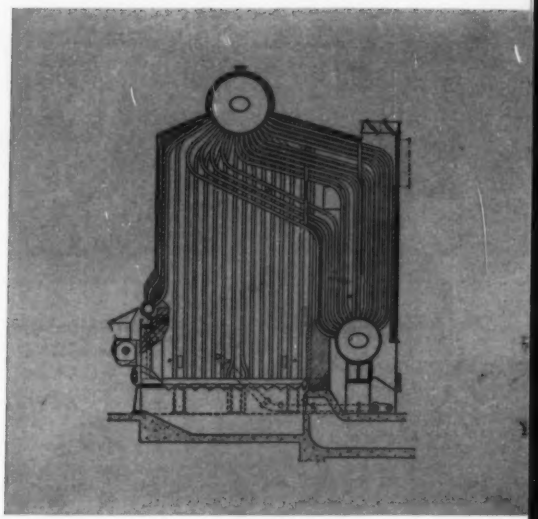


VU-10 Boiler — This unit, one of two duplicates, is in service in an Eastern steel mill. It is fired with a C-E Spreader Stoker. Capacity — 22,500 lb steam per hr; operating pressure — 100 psi; no superheat.

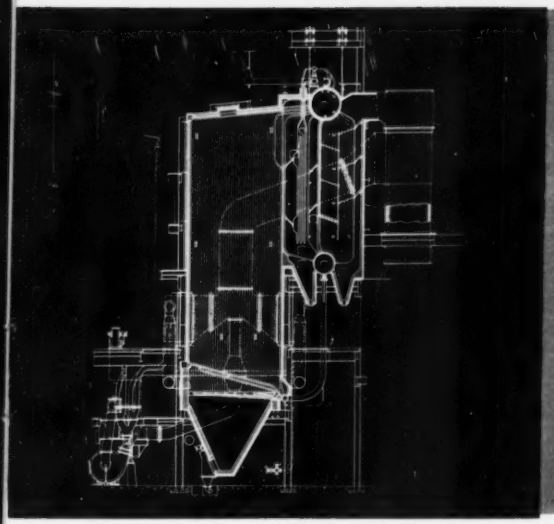
Industry Leaders

One significant fact about the C-E Vertical-Unit Boiler is its wide acceptance by leading companies in practically every industry. This is so important to *all* companies because buying decisions of the larger manufacturers are often a practical guide for everyone right down the line.

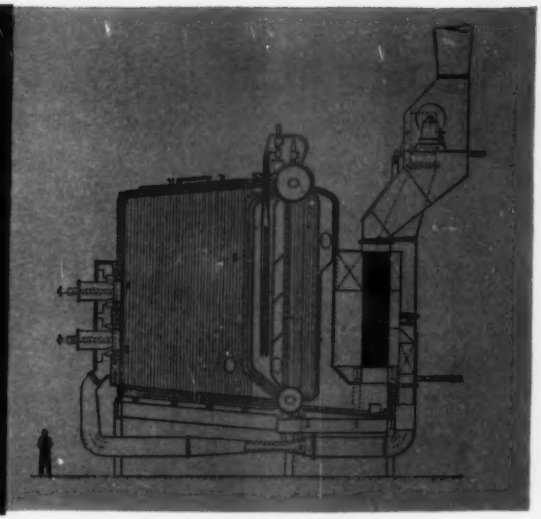
Primary metal producers are an outstanding example. The reliability of their steam generating equipment is of utmost importance, since steam failure may cause extensive damage to costly equipment. It is especially significant then that many of the world's largest metal producers, each guided by its own investigations and conclusions, reached a common decision as to the merits of Vertical-Unit Boilers.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



VU-50 Boiler — This unit, one of five duplicates, is in service in a large tube mill. It is designed to burn pulverized coal and blast furnace gas. Capacity — 175,000 lb steam per hr; operating pressure — 850 psi; steam temp. 750 F.



VU-50 Boiler — This unit, one of five duplicates, is in service at a Midwestern steel plant. It is designed to burn blast furnace gas and coke oven gas. Capacity — 100,000 lb steam per hr; operating pressure — 425 psi; steam temp. 700 F.

select VU

These companies have *proved* their satisfaction with VU Units by buying them again and again. One company purchased three in 1940 . . . three more in 1946 . . . five in 1949 . . . and two in 1951 — *thirteen units in eleven years.* In fact, the fourteen companies listed here have bought a total of 69 Vertical-Unit Boilers.

You can profit from the example of the primary metal industry — or from any industry where steam is exceptionally important. You will find — as so many others have found — that the C-E Vertical-Unit Boiler means lower steam costs through advanced design . . . sound construction . . . proved reliability. If you need steam — from 10,000 to 350,000 pounds per hour — take a tip from the leaders — investigate VU.

Leading Metal Producers using VU units in one or more plants

Aluminum Company of Canada, Ltd.
Anaconda Wire & Cable Co.
Bethlehem Steel Co.
Bridgeport Brass Co.
Chase Brass & Copper Co., Inc.
Cia. Siderurgica Nacional
Great Lakes Steel Corp.
Jones & Laughlin Steel Corp.
National Tube Co.
Phelps Dodge Corp.
Pittsburgh Steel Co.
Republic Steel Corp.
Revere Copper and Brass Inc.
Sloss-Sheffield Steel & Iron Co.

B-625

— SUPERHEATER, INC.
200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

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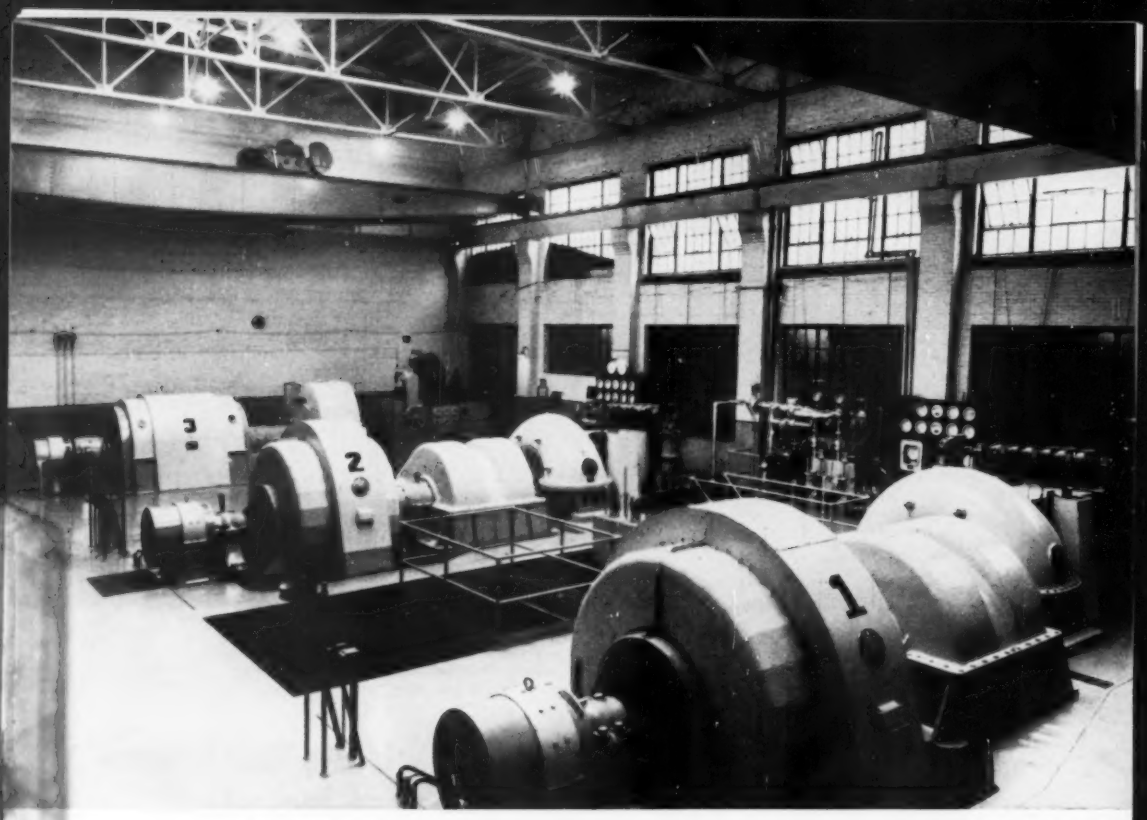

17-year record shows savings you can make with...

NONPAREIL
TRADE MARK
Turbine Oil

• Turbine oil changed every three years, oil systems cleaned every year, filters cleaned every four months . . . that was the oil system maintenance routine in the power plant of a mid-west paper mill before the switch was made to NONPAREIL Turbine Oil.

Recommended by a Standard Oil lubrication specialist, NONPAREIL has been used for 17 years in the plant's two 4,000-KW units and for 12 years in its 5,000-KW unit. The original fills of oil have never been removed from the turbines. Neutralization numbers have remained below 0.09 mg. KOH/gm. The oil systems have never needed cleaning.

While the lubricant and maintenance savings already realized by this power plant are impressive, they are just a beginning. Trouble-free lubrication and consequent savings are *assured for the life of these turbines.* This is based on the written guarantee, given with each fill of NONPAREIL, that this unique lubricant will last as long as the turbine, and that its neutralization number will stay below 0.15 mg. KOH/gm.

A Standard Oil lubrication specialist will be glad to show you record after record, each covering over 20 years' operation, where NONPAREIL has eliminated oil replacements, oil system cleaning, and troubles caused by excessive oil acidity. All you need do is phone your local Standard Oil (Indiana) office. Or, write Standard Oil Company, 910 South Michigan Ave., Chicago 80, Illinois.

STANDARD OIL COMPANY
(Indiana)

STANDARD

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"I sure did specify Hagan Automatic Combustion Controls,

and here's why... I specified Hagan Combustion Controls because they are accurate. We don't waste fuel with them. They are built to last, too, and they require practically no maintenance."

Dependability is important. So is accuracy. If as little as one per cent of the fuel your boiler uses during its life is wasted, the cost of this wasted fuel can be five, six or seven times the original cost of the control system!

That is why you are *not* saving money if you buy anything less than the best—dependable Hagan Combustion Controls.

Our engineers are at your service, and will be glad to discuss all types of combustion control applications with you. For full information, write, wire or phone Hagan Corporation.

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN HALL BUROMIN CALGON

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AUTOMOTIVE AND
AERONAUTICAL TESTING LABORATORIES

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For more data circle 508 on Post Card

cochrane
water conditioning

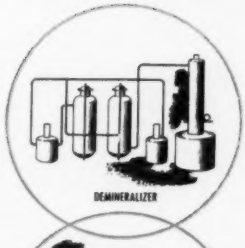
STARTS WHERE NATURE STOPS

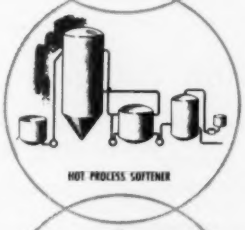
Nature's purest water will not meet the stringent requirements of modern industrial processing. The presence of minerals, salts or gases makes it unsuitable or uneconomical for direct use. Profitable elimination of corrosive or process retarding elements requires specialized experience such as furnished by Cochrane Water Engineers.

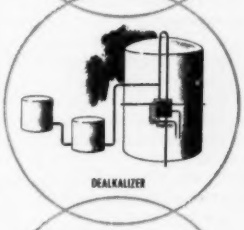
Engineering wisdom dictates that it is not so important to know all the answers as to know where to get them. The problems of Ion Exchange, Demineralization, Deaeration, Dealkalization, and others are complex; and there is only one *best* solution to any set of conditions. That's why leading engineers and consultants call on Cochrane for the answers.

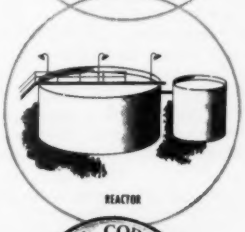
To any water conditioning problem Cochrane contributes 89 years of accumulated "know-how". Whether your requirements are for process water or boiler feedwater, Cochrane can show you how to obtain them—economically and efficiently. And since Cochrane manufactures all types of water conditioning equipment, you are assured unbiased recommendations.

When you have a water conditioning problem call on Cochrane. Your requirements will be thoroughly surveyed by a Cochrane Water Engineer . . . then you'll know you're right. To give you prompt consultation and service, Cochrane Water Engineers are strategically located in 29 cities throughout the United States. Write today for the address of our office nearest you.









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corp. 3123 N. 17TH STREET, PHILADELPHIA 32, PA.

In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Babcock & Wilcox de Mexico, S.A., Mexico City
In Europe: Recuperation Thermique & Epuration, Paris

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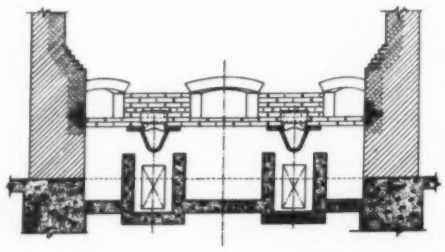
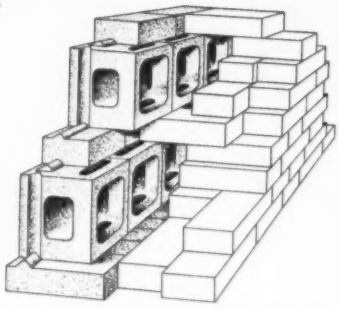


CRYSTOLON
Solid Brick
Construction



CRYSTOLON
Air-Cooled
Block
Construction

Avoid Boiler Furnace Shutdowns...

with CRYSTOLON refractories protecting the "Trouble Zone"*

With the right kind of wall protection in your boiler furnaces, you cut shutdowns and maintenance costs to a minimum.

Norton CRYSTOLON (silicon carbide) refractory shapes — solid bricks or hollow air-cooled blocks — form a real "safety belt" for this trouble zone. That's because they offer outstanding protection against these three frequent causes of furnace failure:

High Heat. CRYSTOLON shapes are so highly refractory that they withstand temperatures up to 3100 F.

Slag Penetration. CRYSTOLON bricks and blocks, made with a maximum percentage of silicon carbide, are so structurally dense that even when clinkers adhere — which happens very rarely — they can be easily removed.

Abrasion. CRYSTOLON silicon carbide, being a tough abrasive itself, is not noticeably affected by the abrasion of the moving fire beds of stoker-fired furnaces.

Why waste time, trouble and money on refractories that spall, erode or crack? Investigate how quickly CRYSTOLON shapes pay for themselves with trouble-free service.

Norton RA1019 ALUNDUM* Cement adds extra life to furnace walls

One way to assure long lasting boiler furnace walls is to lay up your brick with Norton RA1019 ALUNDUM cement. Containing 80% fused alumina, this fine-ground, chemically stable cement matures at 1850 F and resists temperatures up to 3100 F — qualities that mean strong, thin, firmly sealed joints in both silicon carbide and fused alumina brick.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

CRYSTOLON Armor Blocks in your water tube boilers give low-cost protection against high heat

High refractoriness that stands up under today's increasing boiler furnace temperatures is just one big advantage of Norton CRYSTOLON Armor Blocks. In addition, they have great resistance to slag penetration and abrasion — plus the high thermal conductivity that promotes even heat distribution and affords maximum protection to tubes from localized heat generation and flame impingement.

Installation is easy and inexpensive. Adjoining surfaces of blocks are tapered, for secure locking and intimate contact with tubes. Bent or straight tube sections can be replaced from the fire side and are laid dry, further reducing installation costs. Tubes require no cleaning or grinding.

For prices and full information, send data on tube diameters, tube spacing, radius of curvature of bent sections and areas to be curved.

Know the Facts

These two Norton bulletins contain plenty of valuable information on the properties and selection of both refractory brick and cement. Ask your Norton Representative for Bulletins 80‡ and 863, or write direct to NORTON COMPANY, 625 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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LADISH

Controlled Quality

PIPE FITTINGS

maximum service assured by metallurgical soundness

Sound metallurgy . . . the result of unsurpassed facilities and advanced laboratory controls . . . provides the maximum of dependability in Ladish Controlled Quality fittings. Every phase of metal quality . . . composition, structure and physical properties . . . is continuously safeguarded — and certified proof of metallurgical integrity is available to users of Ladish fittings.

TO MARK PROGRESS

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF . . . ONE RESPONSIBILITY

LADISH CO.

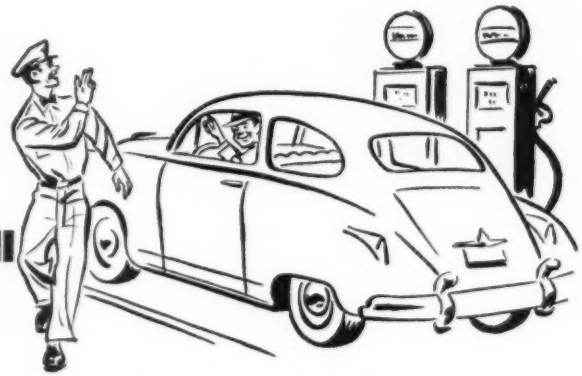
CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • San Francisco • Havana • Mexico City • Brantford, Ont.

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"



Nobody knows for sure how it started—this line about "See you at the Polls!" we're hearing all over these days.

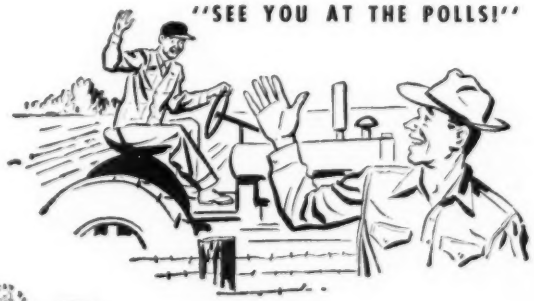
Best explanation seems to be that it came from that state candidate out west. . . . His opponent in a debate got all riled up and challenged him to fight it out in the alley.

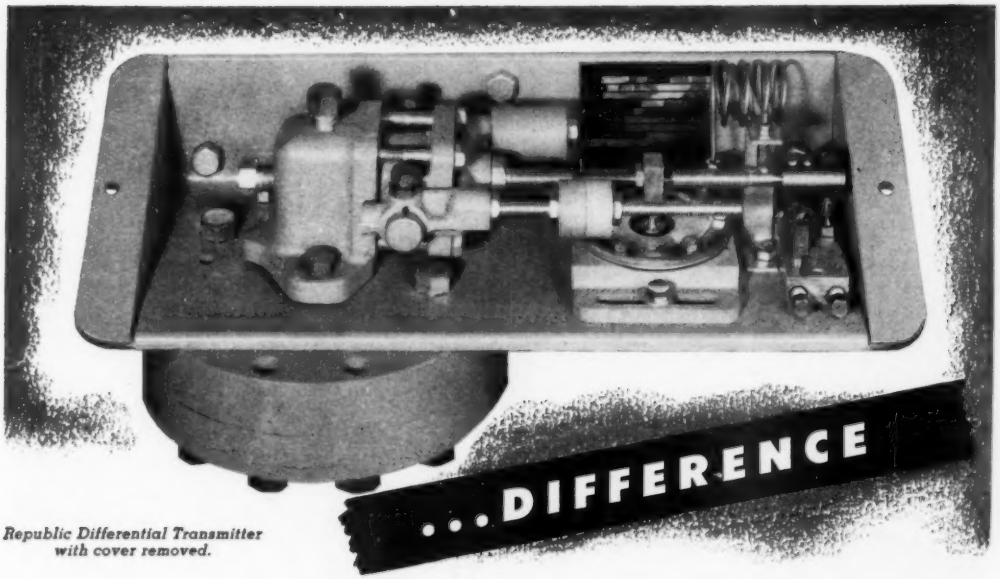
But he said—"I'll settle this the AMERICAN way—I'll see you at the polls!" And the audience picked up the chant.

Now everybody's saying it—and on Nov. 4 everybody will be *doing* it!

"SEE YOU AT THE POLLS!"

"SEE YOU AT THE POLLS!"





Republic Differential Transmitter with cover removed.

Spells *PLUS* PERFORMANCE

The Republic Pneumatic Transmitter combines machine ruggedness with instrument precision to provide matchless performance in measuring flow, level, pressure or density of a wide variety fluids. By any or all of the following points, the Republic challenges comparison:

ACCURACY of the Republic force-balance principle is higher than can be consistently secured and maintained with any other method. 1/2 of 1% guaranteed.

TEMPERATURE variations of ambient atmosphere have negligible effect on the accuracy of the Republic transmitter.

CHANGES IN AIR SUPPLY PRESSURE do not affect the accuracy of a Republic transmitter to any significant extent. A 5 psi change produces an error of less than 1/10%.

CHANGES IN LINE PRESSURE—Republic differential transmitters are not affected by variations in line pressure. A patented and exclusive simple adjustment assures this protection.

SENSITIVITY—Due to the negligible motions required for complete operation of all parts, for a full scale change, no appreciable hysteresis results from reversal of direction of measurement change.

VIBRATION of any normal frequency has no effect on the Republic transmitter.

LEVELING—Since all parts are balanced, and no liquid is used for calibration, Republic transmitters need not be leveled exactly, and may be adjusted for installation in any position.

FOR TWELVE YEARS Republic Pneumatic Transmitters have delivered unmatched performance in every type of installation. Complete details of design and operation, plus numerous application suggestions are combined in Data Book, 1002. Send for your copy, today.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

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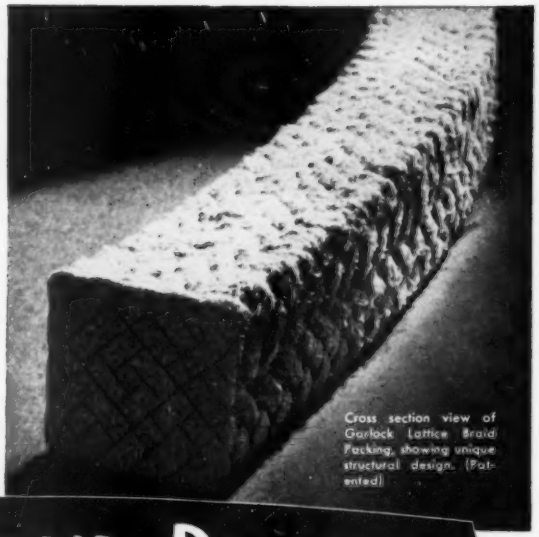
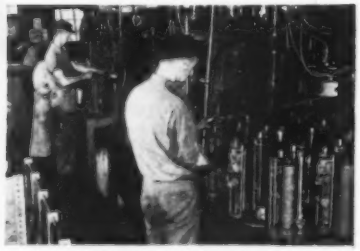
For Long Trouble-Free Service USE



Cross section view of Garlock Lattice Braid Packing, showing unique structural design. (Patented)

LATTICE-BRAID PACKING

GARLOCK 751 (cotton) Lattice-Braid Packing for hot or cold water.



GARLOCK'S specially designed Lattice-Braiding machines.

The Greatest Improvement Ever Made in Braided Packings!

The strands of Garlock Lattice-Braid packings are braided *through* and *through* on specially designed braiding machines. Since all strands are strongly linked together into a single unit, they are firmly held together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

This exclusive lattice braiding also provides unusual flexibility and semi-automatic pressure action which keeps the packing properly adjusted in the stuffing box. Longer service with less attention.

Garlock Lattice-Braid is manufactured from flax, cotton, asbestos, wire-inserted asbestos and "Teflon"—for various types of service. Furnished in ring, coil or on reels.

Write today for the new Lattice-Braid Folder.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

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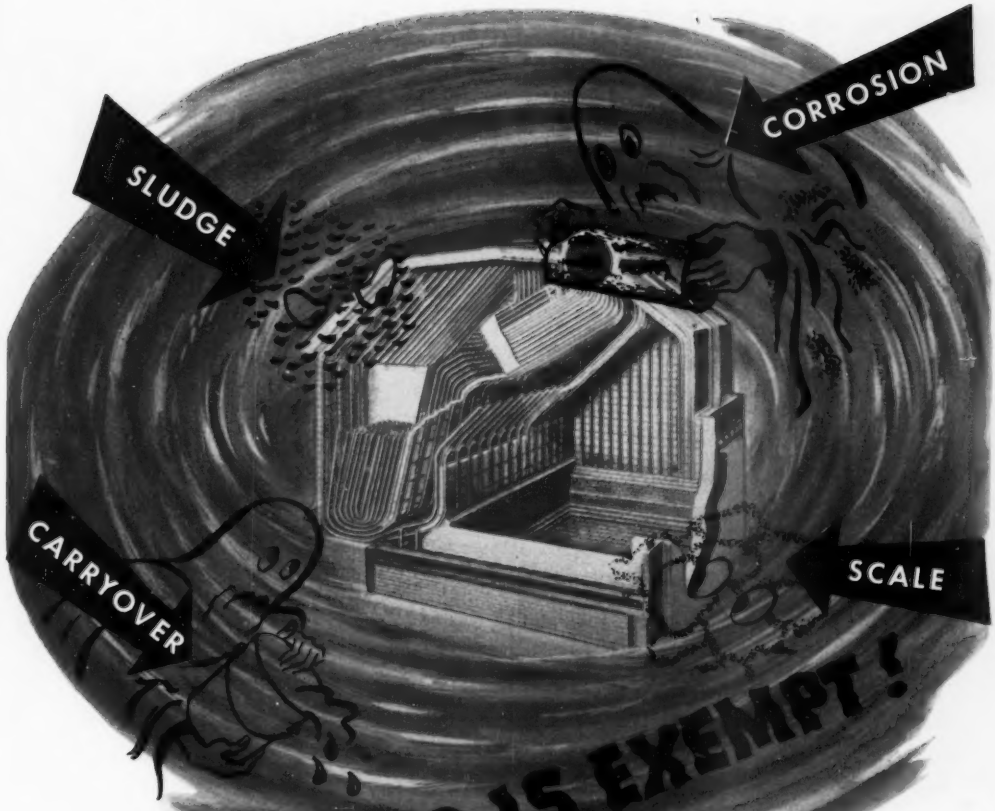

NO BOILER IS EXEMPT!

That's why we say "draw a bead on boiler sludge, scale, corrosion and carryover"

Tube failure, expense and inconvenience . . .
even plant shut down await those who ignore these potential difficulties in their boiler operations.

Call in the Drew Engineer for thorough investigation, specific recommendations, proper treatment and frequent follow-up service that will clear up your boiler troubles or stop them before they start.

Write for the new booklet "Drew Boiler Water Treatment" describing methods used in overcoming boiler water problems.

Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

SAN FRANCISCO CHICAGO PHILADELPHIA BOSTON DALLAS
AJAX, ONTARIO

Service throughout the United States, Canada and South America

DREW PRODUCTS

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BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Figure 1. Barbadoes Island Station of Philadelphia Electric & Power Company.

Barbadoes Island Power Output Increased 275%

Generating enough power to supply the electrical needs of more than 500,000 families, the recently expanded Barbadoes Station of the Philadelphia Electric & Power Company is an outstanding example of a modern, efficient power plant.

Located on historic Barbadoes Island in the Schuylkill River between Norristown and Bridgeport, Pennsylvania, the station originally had a capacity of 48,000 KW. In 1949, two new turbo-generators were placed in service, each with an effective rating of 66,000 KW. The present capacity of the four operating units is 180,000 KW, which is used to supply the northwestern portion of Philadelphia Electric's territory.

Unit Arrangement for Reliable Performance

For the operation of the installations, a modified unit arrangement was adopted for simplicity and reliability. The turbo-generators, feedwater systems, main steam systems, draft and dust collector systems are kept separate, thus preventing any possible difficulty in one unit from affecting the operation of the other. The principal diversions from the unit arrangement are circulating water tunnels, cooling water system, stack and an auxiliary steam system.

Efficient Use of Bleed Steam

The heat balance diagram for one of the two identical units is shown in Figure 2. The economical use of bleed steam for producing feedwater temperatures suitable for the boiler design is apparent in this diagram.

Both main condensers are radial flow, two-pass, non-divided water-box type with 37,500 square feet of effective surface. Each condenses 375,000 pounds of steam per hour at 1 inch Hg. absolute pressure when supplied with 40,000 gpm cooling water at 50° F.

There are a total of 7,450 Admiralty tubes in the condenser. These tubes are 18BWG, ⅞ inch in diameter, with a wall thickness of .049 inches. The expected life of the tubes is from 15 to 20 years, based on the previous performance of other tubes of the same alloy with Schuylkill River water.

The air ejector for each unit is equipped with two banks of two-stage ejectors mounted on an inter and after condenser. They are designed for use with 400 psig motive steam to remove 8 cfm of free air and associated water vapor at 70° F. The drain coolers are horizontal, two-pass units, each designed to heat 555,000 pounds of concentrate an hour.

All five feedwater heaters, in each system, are of the vertical, channel end up, four-pass, straight condensing type, designed to handle the same amount of concentrate per hour as the drain cooler. The operating water pressure through the tubes is 600 psig, although they are capable of handling 725 psig. The table in Figure 3 shows the number, dimensions and alloy of the tubes used in each of the heaters.

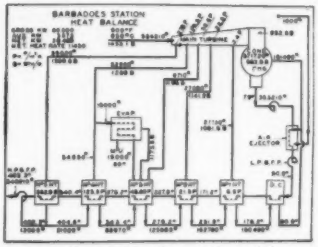


Figure 2. Heat balance diagram of one of the two identical units recently installed at Barbadoes Station.

Bridgeport Corrosion Laboratory

Changing operating conditions, new designs in equipment, and improvements in efficiency of power production call for alloys with special properties. Bridgeport's Corrosion Laboratory will be glad to work with designers, builders, and operators of power plants to help select the copper-base alloys which will give the most dependable service. Contact the nearest Bridgeport branch office for your condenser and heat exchanger tube requirements.

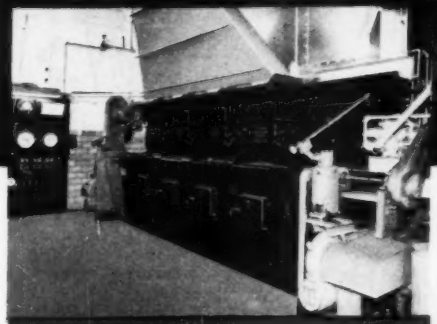
(8759)

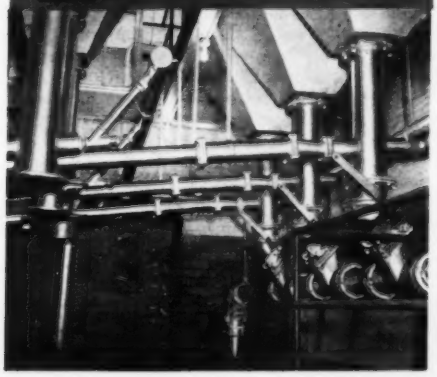
ITEM	NO. OF TUBES	SIZE (dia.)	GAGE	LENGTH	ALLOY
Drain Cooler	460	¾"	16	216"	Admiralty
#1 Heater	798	¾"	16	180"	Admiralty
#2 Heater	820	¾"	16	162"	Admiralty
#3 Heater	820	¾"	16	156"	Admiralty
#4 Heater	820	¾"	16	174"	Admiralty
#5 Heater	820	¾"	18	199"	70-30 Cupro-Nickel

Figure 3. Sizes and alloys of condenser tubing used in drain coolers and feedwater heaters.

For more data circle 516 on Post Card

Nash Motors SELECTS
DETROIT ROTOGRATE STOKERS





Nash Motors, Division of Nash-Kelvinator Corporation purchased two 100,000 pound per hour RotoGrate Stokers for their Kenosha plant. Boilers are Babcock and Wilcox 4 drum Stirling with superheaters and economizers. A similar stoker unit was purchased for the Nash Milwaukee plant.

Detroit RotoGrate is an improved spreader stoker. Grates move slowly forward to discharge the ash at the front. Coal feed, grate speed and air supply are synchronized at all capacities. A wide range of Bituminous Coal or Lignite may be burned. Controlled high turbulence and rugged, dependable cinder reinjection system contribute to fuel economy. Grates are of unique design which permits more burning capacity per square foot.

Write for RotoGrate Bulletin.

DETROIT STOKER COMPANY

GENERAL MOTORS BLDG., DETROIT 2, MICH.

District Offices in Principal Cities · Works in Monroe, Mich.

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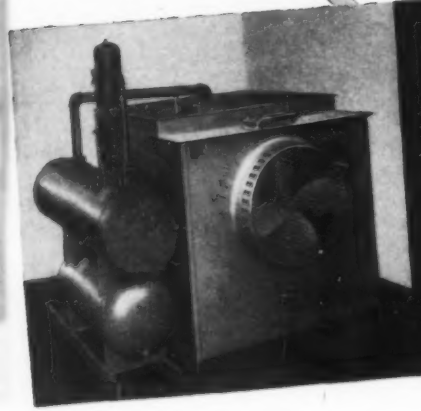
New

SAVES WATER and CUTS MAINTENANCE COSTS . . .

Illustrations show two views of a 55 ton Condenser Tower prior to partial disassembly for shipment.



Vogt

CONDENSER TOWER

FOR CONDENSING REFRIGERANTS

SINGLE RESPONSIBILITY:

Vogt, leading builder of refrigeration condensers, assumes responsibility for engineering the unit. Only one purchase order needed.

SHOP FITTED:

To cut down field assembly labor. Requires no cutting or fitting of pipe.

Designed for today's water conservation requirements, and to keep refrigeration costs low, the *new* Vogt Condenser Tower meets the need for a proven, readily cleanable condensing unit.

The Vogt Condenser Tower consists of a multipass straight tube condenser, a receiver, an oil trap, a cooling tower, and a water pump. Removable cast iron heads permit easy cleaning of the condenser tubes.

Water costs are extremely low since the cooling water is recirculated continuously and requires only a small amount of makeup to replace losses due to windage and evaporation.

Condenser Tower units are available in capacities ranging from 5 to 50 tons refrigeration. Additional information will be furnished upon request.

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

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FROM THE TOP STEEL PRODUCER . . .
TO A LEADING CHEMICAL HOUSE,
A YEAST COMPANY
AND A MEAT PACKER . . .

Heat Prover SERVES 62 DIFFERENT COMPANIES IN THE GREAT CHICAGO INDUSTRIAL AREA!

The Cities Service Heat Prover is graphically proving its worth to all kinds of industry in the Chicago area and elsewhere throughout the country.

62 different companies, producing everything from steel to beef, have found the Heat Prover an important aid to increased production and big dollar economy.

WHEREVER A FURNACE OPERATION IS INVOLVED, Heat Prover can help increase productivity by providing:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
5. **No maintenance; no re-calibration.**

REMEMBER: Heat Prover is not an instrument you buy but a service we supply. Contact the Cities Service office in your area and learn how Heat Prover can serve you . . . or write CITIES SERVICE OIL COMPANY, Dept. K 23, Sixty Wall Tower, New York City 5.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

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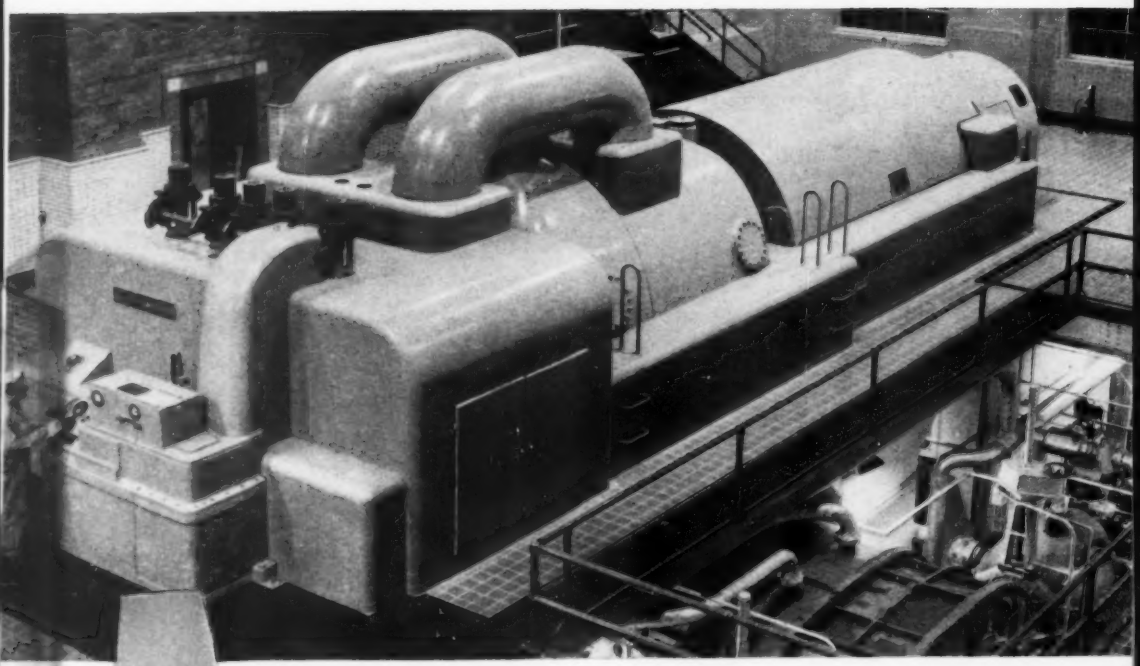
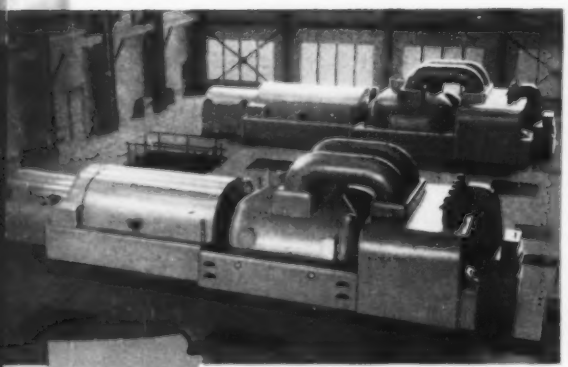
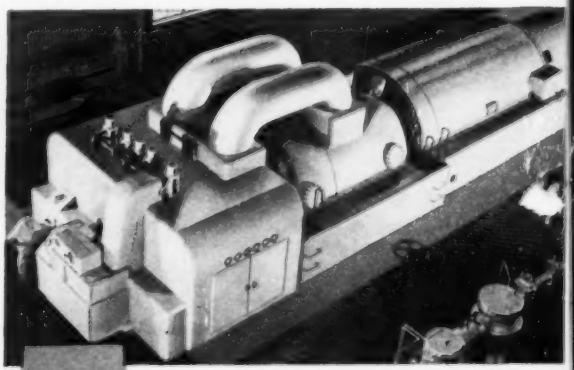
POWER for the



ALABAMA area has experienced an industrial power consumption rise of over 12½% in one year's time. To help meet this rocketing power demand, the Alabama Power Company just recently installed this Allis-Chalmers 40,000 kw steam turbine hydrogen cooled generating unit at its Chickasaw station in Mobile. A-C also supplied the 30,000 sq ft surface condenser and its auxiliaries, including two 25,000 gpm circulating pumps and motors.



ARKANSAS has the largest U. S. deposit of bauxite ore, primary to the production of aluminum. These two Allis-Chalmers 40,000 kw condensing, tandem compound steam turbine hydrogen cooled generating units form the Lake Catherine steam-electric station of the Arkansas Power & Light Company. Most of this power is used to electrolytically reduce alumina.



LOUISIANA industry and agriculture are mushrooming. The Gulf States Utilities Company — serving an area from Baton Rouge to across the Brazos River in Texas—has doubled its customers and tripled its power generation in the last decade. A-C recently supplied 75,000 kw in generating capacity to Riverside station near port city of Lake Charles. Unit shown is 40,000 kw.

Booming South!

NEW ALLIS-CHALMERS TURBINE-GENERATORS HELP SUPPLY MUSHROOMING INDUSTRIAL DEMAND

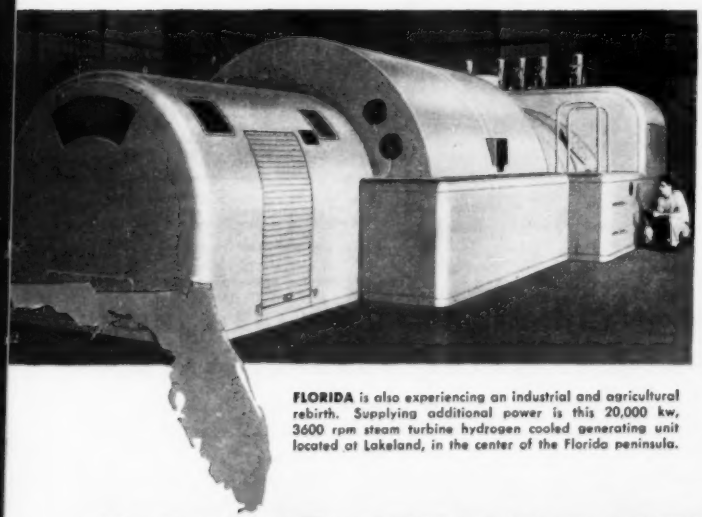
YOU'VE HEARD OF the South's mushrooming industrial growth. Here are some of the Allis-Chalmers steam turbine generator units newly installed to help satisfy that insistent power demand.

All these modern units conform to AIEE-ASME preferred standards in addition to incorporating many exclusive Allis-Chalmers main design features. The hydrogen cooled generators all have the A-C originated "walk-in" exciter housings. And these 3600 rpm turbines all have the following outstanding features:

Hydraulic control and operation with accessible placement of main stop valve; centralized grouping of operating controls; cam-operated inlet valves accessibly located on top of cylinder; and exclusive A-C method of temperature compensation for horizontal *and* vertical thermal movement.

All oil piping is above the floor, simplifying foundation and installation. And, as throughout the complete Allis-Chalmers line—ranging from the smallest single cylinder machines to single shaft, tandem compound, condensing units of 150,000 kw — labyrinth steam seals are used. The steam sealed gland system is self-contained and provides dependability with minimum attention.

You get the real design advances *first* from Allis-Chalmers. When planning the installation or expansion of your steam-electric power plant, let A-C simplify your problem. This *one* source will provide you with the world's widest range of power plant equipment. For your copies of literature on all products mentioned, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3842



FLORIDA is also experiencing an industrial and agricultural rebirth. Supplying additional power is this 20,000 kw, 3600 rpm steam turbine hydrogen cooled generating unit located at Lakeland, in the center of the Florida peninsula.

ALLIS-CHALMERS *firsts*

Simplified hydrogen seal and control

World's lowest exhaust pressure steam turbines

Solidly-bolted-down steam end pedestal

Turbine for one-boiler-per-turbine arrangement

"Walk-in" exciter housing

30,000 kw, 825 F turbine, in 1931

825 F reheat turbine, in 1935

AND NOW... First with supercharged hydrogen cooling!

ALLIS-CHALMERS

World's Widest Range of Power Plant Equipment

TURBINES & GENERATORS | CONDENSERS & PUMPS | SWITCHGEAR & BREAKERS | MOTORS & CONTROL | TRANSFORMERS | WATER CONDITIONING

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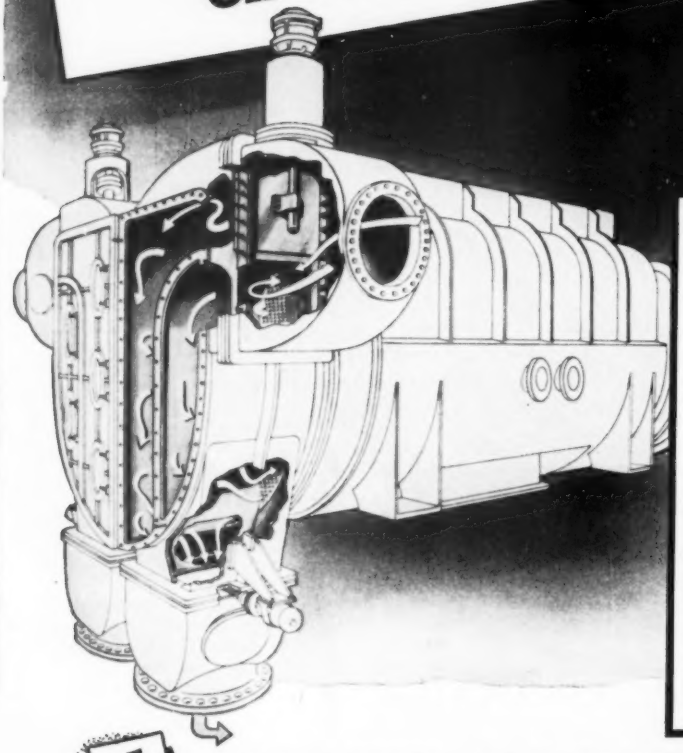
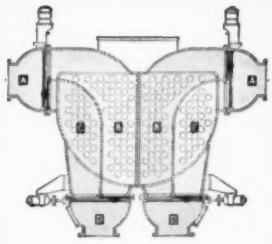
electrolytically reduce alumina.

city of Lake Charles. Unit shown is 40,000 kw.

Here's a 3-WAY "ASSIST" On Your Power Plant Problems





HERE IS HOW REVERSE FLOW WORKS

Reverse flow sluice gates on divided water box condensers work the same in both halves but independently of each other. Right side: normal flow. Water enters divided water box in valve chamber "A" with lower port open. It flows through pass "C" to end of condenser, back through pass "B" and out through left port of "D."

Left side: flow is reversed. Valves at inlet "A" and discharge "D" are changed to permit water to flow through "B" and back through "C" in the opposite direction and then out through the left port of "D."

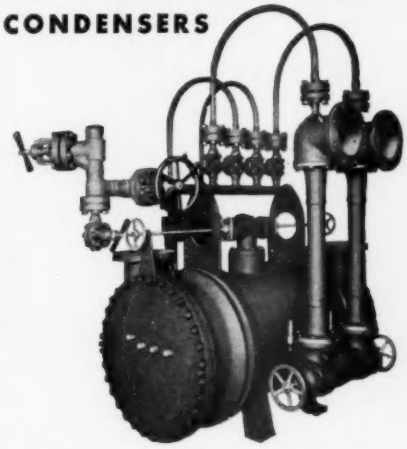
1 CLEAN DEBRIS FROM CONDENSER TUBE SHEETS WITHOUT DOWNTIME OR LOSS OF VACUUM

C. H. Wheeler "Reverse Flow" Condenser design provides a powerful self-cleaning flushing force by the simple procedure of reversing the flow of water through the tubes. Electrically or hydraulically controlled sluice gates accomplish in minutes cleaning that consumes hours of downtime when removal of debris is done by hand. Power plant modernization calls for the efficiency and uninterrupted operation of C. H. Wheeler "Reverse Flow" Condensers. You don't need costly water straining apparatus. Send for latest bulletin #410.

For more data circle 520 on Post Card

2 VACUUM PUMPS WITH LOWEST MAINTENANCE FOR YOUR STEAM CONDENSERS

C. H. Wheeler Steam Jet Ejectors are the development of 35 years of pioneering in this field. Known as "Tubejets," these vacuum pumps have no moving parts. Hence, they are simple to operate, require almost no maintenance and last longer. Modern Power plants use single or two-stage Tubejets with surface inter-after condenser for the vacuum requirements of steam condensers. Special arrangements of standard Wheeler ejector assemblies can be provided for any unusual installation or performance requirements. Catalog #1462 gives you detailed descriptions and some useful temperature and pressure conversion tables. Write for it.



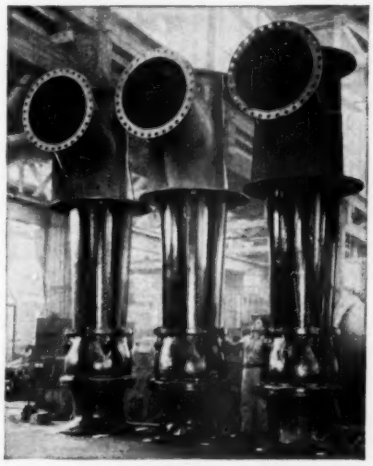
SPECIAL TYPE TUBEJET VACUUM PUMP FOR HIGH PRESSURE AND HIGH SUPERHEAT

3 WHEELER-ECONOMY CIRCULATORS HANDLE LARGER VOLUMES OF WATER AT LOWER COST

Wheeler-Economy Pumps for Condenser Cooling Water Circulation are made in horizontal double suction and vertical submerged, axial mixed flow types. These pumps are noted for reliability, the result of superior modern design and heavy duty, quality construction. They are built in all sizes to meet capacity requirements up to 200,000 GPM. Wheeler-Economy Circulating Pumps are also furnished in special metals to handle corrosive waters. The impellers are designed for satisfactory operation during all load requirements.

Economy engineers are pioneers in the successful application of axial flow pumps in circulator service. These pumps can be furnished in "pull-out" type with distinctive design features, permitting removal of all operating parts, without dismantling the complete pump or disturbing any pipe connections.

For top performance in power plant duty count on Wheeler-Economy Pumps. Write for catalogs #G-349 and G-1050.



THREE CIRCULATORS OF 28,000 G.P.M. CAPACITY, 35 FT. TDH, 575 RPM.

105-R

C. H. WHEELER *of Philadelphia*

C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Cooling Towers • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

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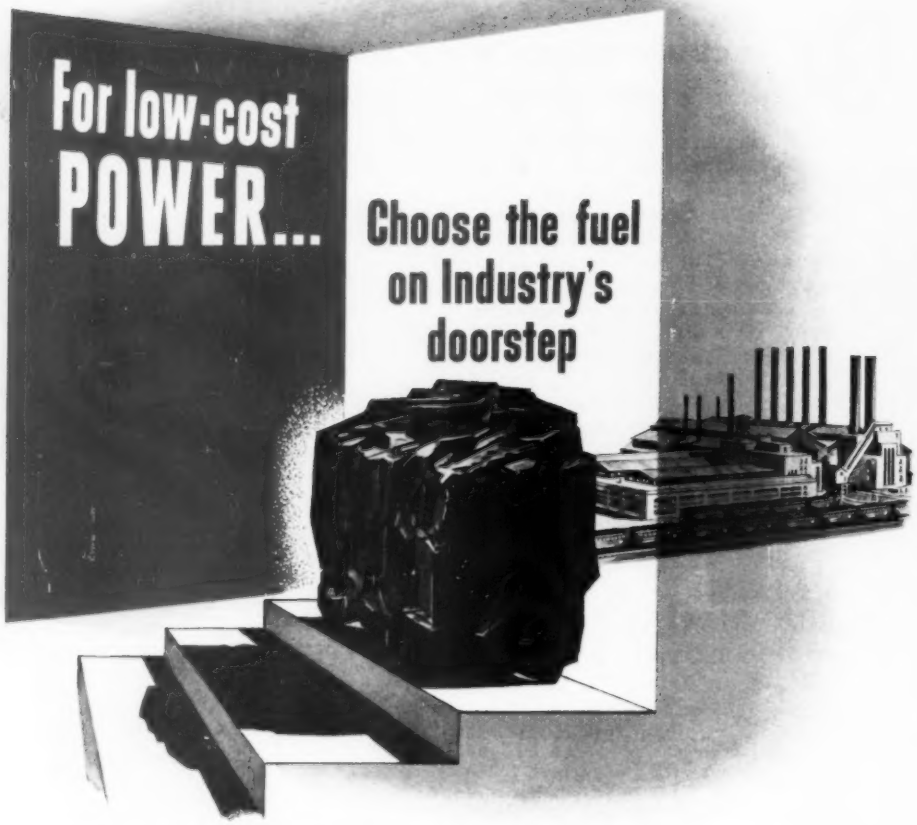
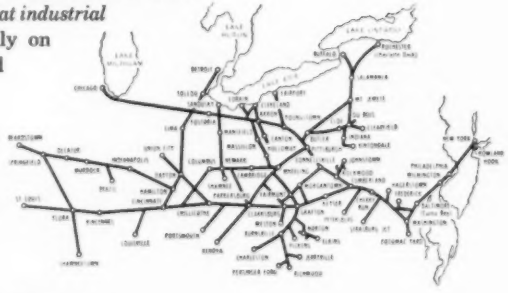
For low-cost POWER...

Choose the fuel on Industry's doorstep



Coal is where you find it. Fortunately, however, a large share of the nation's operating Bituminous mines are located in Baltimore & Ohio territory—*economically accessible to America's great industrial plants.* The Bituminous mined here—practically on Industry's doorstep—is of excellent quality and in wide variety; whatever your specific need, there are B&O coals to meet it. Furthermore, the supply is *inexhaustible*—you can count on an *unlimited* reserve of B&O Bituminous, even in emergencies, for centuries to come.



When you consider fuel, consider cost—dependability of service—*accessibility.* You'll choose the Bituminous mined on the B&O. For advice, *ask our man!*

BITUMINOUS COALS FOR EVERY PURPOSE

LINKING 13 GREAT STATES WITH THE NATION — B&O ®

BALTIMORE & OHIO RAILROAD

Constantly *doing things*—better!

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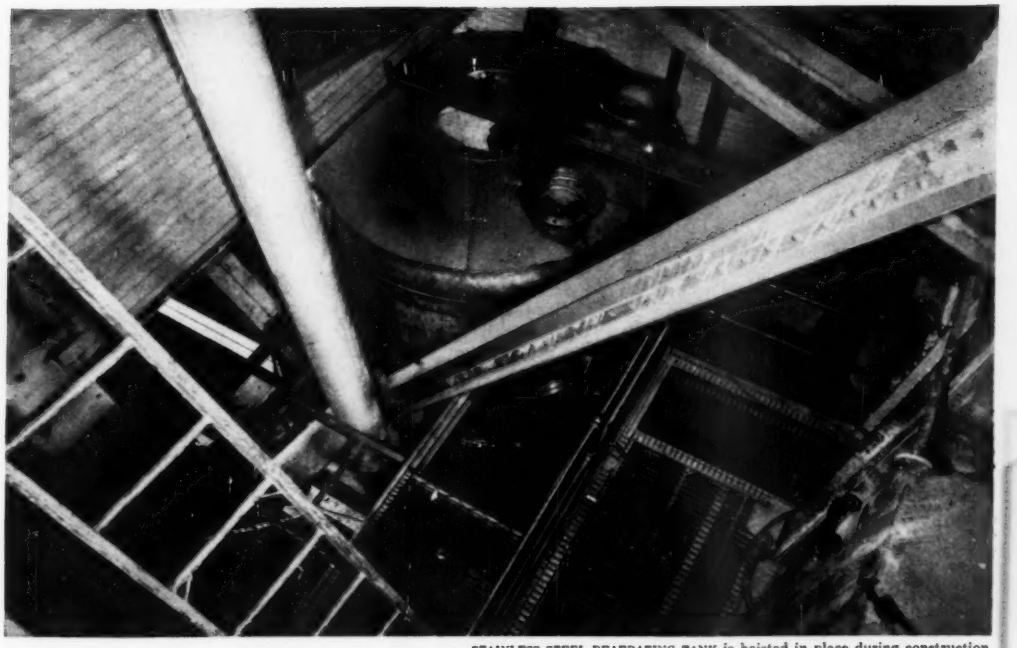


STAINLESS STEEL DEAERATING TANK is hoisted in place during construction of one of Detroit Edison Company's Heating Plants at Detroit, Michigan.

When CO_2 Caused a Headache ...Worthington Cured It

Detroit Edison had the solution to its problem —the problem of CO_2 in its steam—except for one thing.

Zeolite-softened municipal water used in their steam plant contains high percentages of carbonates which decompose and generate CO_2 in the boilers. Carried over with the steam into heating and processing equipment, that CO_2 could cause plenty of trouble.

The CO_2 problem was solved by Detroit Edison engineers by acid treating the softened water, converting the carbonates to CO_2. The gas thus formed is driven off in a deaerator.

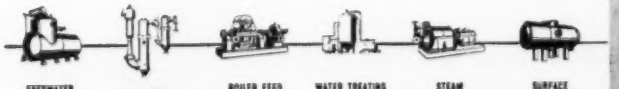
However, no standard deaerator could successfully remove the large quantities of CO_2 released by the acid treatment, and deliver water to the boiler with practically zero oxygen and zero CO_2. Furthermore, standard materials would have lasted only a few months under such conditions.

NON-CONTAMINATED STEAM

Worthington provided the answer. Detroit Edison engineers selected a Worthington deaerator specially designed for these severe conditions, built entirely of stainless steel, and guaranteed to deliver water containing not over 0.005 ppm of oxygen and not over 0.1 ppm of CO_2. The result is steam containing so little CO_2 that the amount *cannot be accurately measured!*

On problems like this one, Worthington not only furnishes *all* of the equipment needed in a complete water treating installation, but also has the engineering ability to work with your engineers on the *complete* problem of generating steam for power or processing. For further information on why *there's more worth in Worthington*, address Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

5.1.2



A GREAT TEAM IN STEAM

WORTHINGTON

Feedwater Heaters

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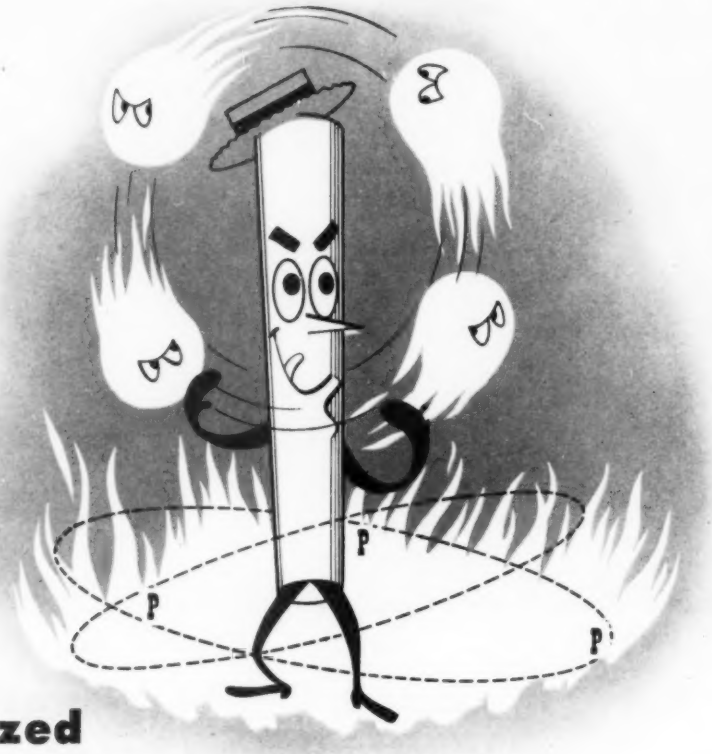

Why Phosphorized Admiralty Condenser Tubes?

Required Heat Transfer Characteristics

In order to assure *uniform* chemical composition and inherent *soundness*, Scovill produces Phosphorized Admiralty tubes by its continuous billet-casting process which consistently maintains the optimum amount of phosphorus. Adding as little as 0.02% phosphorus to Admiralty also gives maximum resistance to dezincification while retaining all the other desirable properties of this alloy.

Scovill's 40-page Condenser Tube Booklet is available to users who request it on their business letterhead. Scovill Manufacturing Company, 15 Mill Street, Waterbury 20, Connecticut.

Only Scovill Phosphorized Admiralty Has All These Advantages . . .

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- High resistance to steam and condensate
- Excellent performance in fresh, salt or brackish waters
- Required heat transfer characteristics
- Superior resistance to general corrosion
- Good resistance to velocities under 7 fps

SCOVILL

A PRODUCT OF SCOVILL

SCOVILL CONDENSER TUBES

"You can't buy better brass"

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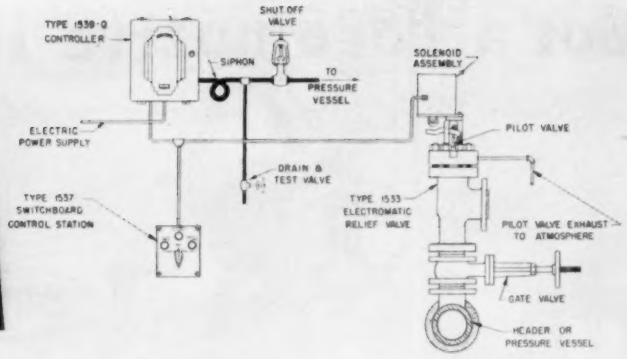
THIS IS THE CONSOLIDATED ELECTROMATIC RELIEF VALVE SYSTEM



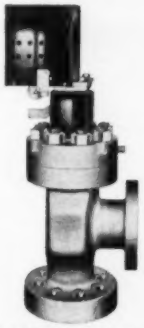
THIS IS WHAT IT GIVES YOU

1. More accurately balanced boiler operation at peak loads.
2. More uniform line pressure.
3. Power conservation.
4. Less maintenance of spring-loaded safety valves.
5. Greater protection against overheating your superheater.
6. Increased efficiency for your steam generating plant.

Automatic, electrically actuated, the Consolidated Electromatic Relief Valve can be set for a differential of 1% or less between opening and closing pressure; relieves pressure precisely within close limits. The valve is operated by a solenoid actuated by a pressure-sensitive element or switch. For automatic or manual service or to cut the valve out of service, just set the switch. Cyclic action is practically instantaneous. Valve operation is not affected by high superheat temperatures or other variables. Manual operation *at any pressure* assures positive circulation through the superheater and greater steam flows during start-up periods than the vent valves normally provide. Danger of burning superheater tubes is minimized under all conditions of service.

You can also use the Consolidated Electromatic as a superheater surge vent or to purge a superheater or header — reduce the possibility of damage to the seats of regular valves and turbine equipment.

Greater efficiency and economy is a "must" in the steam generating plant. That is why the Consolidated Electromatic Relief Valve is important to you. Get complete construction, installation and operating details. Write today for Bulletin 720.



CONSOLIDATED ELECTROMATIC RELIEF VALVE

Sizes:
2½", 4", 10", 14"
Pressures:
Up to 2500 p.s.i.
Temperatures:
Up to 1100° F.
Standard Connections:
A.S.A. flanged and welded.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.
MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

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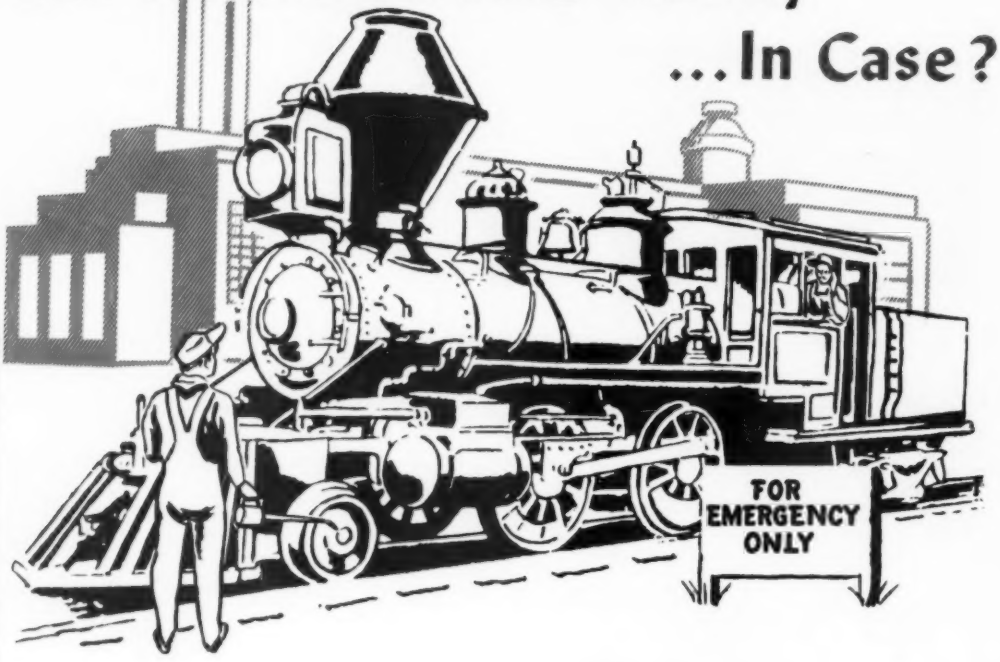
Got a Locomotive Handy ...In Case?



EVERY so often a steam locomotive makes news by going to the rescue of a plant where the steam system gave out at a critical time.

This is one answer to continued steam production pending repairs . . . and undoubtedly an expensive one. Simplest—and most economical—is to use the Nalco System and eliminate the chances of boiler down time due to faulty water treatment.

Nalco chemicals and services aim at *water treatment results* from raw water intake to condensate hot well . . . And the thousands of plants now using the Nalco System testify to the accuracy of this aim during the past twenty-six years. Whether your plant is large or small; your water problems scale, corrosion, carry-over—or just plain high cost—unless you have a locomotive handy for emergencies, better check with Nalco today. No obligation . . . and an excellent chance for permanent water treatment security.

P. S. More steam locomotives use Nalco-treated water than any other kind . . . Perhaps the reason why locomotives *can* be of help in plant emergencies!

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to
Alchem Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

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Helpful Bulletins

THE ANSWERS to many of your operating and maintenance problems are found in these new and recently revised catalogs and bulletins. Circle item numbers of all catalogs wanted on the postage-free card below, detach and mail

VALVES, TRAPS AND PIPING ACCESSORIES

101 **Valve Selection Booklet** — Sixteen-pp Catalog 12-H, covering company's Pressure-Seal stop, check and non-return valves, gives descriptive data, design characteristics and dimensional details. Provides tables and charts for easy calculation of pressure drop, as well as complete material specifications including chemical analyses and physical characteristics. Cutaway photos and drawings illustrate the Pressure-Seal construction and company's Equalizer, showing their advantages. Edward Valves, Inc.

102 **Expansion Joints** — Manufacturer's recently redesigned Flexon line of expansion joints is featured in 16-pp Catalog CMH-128. Complete specifications and other data are given for the new joints, which offer increased traverse per corrugation. Also presented in this catalog is information on corrugated and convoluted types of flexible metal hose, including couplings, flanges, nipples and assemblies. Flexonics Corp.

103 **For Pipe Fabrication** — Bulletin P-2 describes and pictures company's Pantograph for making all types of beveled cut-offs used in pipe fabrication work. Operation of the cutter is explained, its features and advantages listed. Optional equipment for use with it is pictured. Vernon Tool Co., Ltd.

104 **Steam and Air Traps** — Twelve-pp Bulletin 213 is a revised edition of company's condensed catalog on traps. Contains a sequence of diagrams explaining operating principle and design features of company's inverted bucket traps. Prices, physical data and other details on cast semi-steel and forged steel steam traps, and ball float air and air-relief traps are included. Data is also given on internal check valves, and special traps. A capacity chart shows continuous discharge capacities at various pressures. Armstrong Machine Works.

PUMPS AND COMPRESSORS

105 **Cradle-Mounted Pumps** — Sixteen-pp Form 7223, covering general purpose centrifugal pumps of the cradle-mounted type, presents five basic groups and 17 corresponding pump types, their capacities, horsepower ratings and uses. There are also pages on pump dimensions and a table of performance under 60 cycle use. Special purpose units and modifications shown. Ingersoll-Rand Co.

106 **Chemical Proportioning Pumps** — Bulletin 1225, 8 pp, gives latest information on company's heavy-duty Chem-O-Feeders — small proportioning pumps available with one, two or three measuring chambers for capacities to 57 gph and supplied as a "package." Gives specifications and features along with installation diagrams, and list of chemicals fed. %Proportioneers, Inc.%

107 **High Pressure Pumps** — Plant engineers with high pressure pumping problems will find in 6-pp Bulletin 48-295 dimensions, capacities, cutaway drawings on pumps from 600 to 5000 psi or 1.1 to 16.5 gpm. Direct drive and back-geared models are described for such uses as high pressure testing or back washing of pipes, valves, vessels, boilers — for high pressure boiler feeding, bending. American-Marsh Pumps, Inc.

108 **FHP Air Compressors** — Manufacturer's Monobloc air compressors capable of 2.6 to 5.0 cfm and up to 150 psi pressure are the subject of Specification Sheet H-605-B2. Discusses valves, cyclinder head crankcase and other components of these compressors which are designed for pressure spraying, dry pipe sprinkler systems, pressure lubrication and general small capacity use. Worthington Corp.

MECHANICAL POWER TRANSMISSION

110 **Data on Speed Reducers** — Twenty-pp Bulletin A-614-A offers in compact form full engineering information and selection data on manufacturer's line of Torque-Arm speed reducers and a new overload release designed for use with the reducers. Data and tables have been revised to include a new reducer which increases the capacity range to 43 hp. This line of shaft-mounted reducers covers a speed range of 12 to 330 rpm. A quick method of selection is presented, and in addition to perspective illustrations of reducer and release, this booklet includes sectional views and engineering diagrams. Dodge Mfg. Corp.

111 **Air Cylinders** — Bulletin A-105G uses only 8 pp to present complete engineering, design, construction and mounting data (including all mounting drawings) and dimension tables covering 13 mounting styles in 1½ through 14 in. bores. It's designed for easy selection of proper model. Covers cushioned and non-cushioned cylinders, single and double acting, single and double rod end, spring return and over-sized rod cylinders. Miller Motor Co.

It's easy to get these free catalogs—just circle item numbers of those wanted on the post card below

NOVEMBER, 1952
Card void in 6 months

POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the numbers circled below.

Name.....Title.....

Company Name.....

Company Address.....

City.....State.....
(If you prefer delivery at home, give home address, too)

Home Address.....

City.....State.....

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4 5 6	107 108 109 110 111 112	213 214 215 216 217 218 219 220 221 222 223 224	522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542
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25 26 27	149 150 151 152 153 154	297 298 299 300 301 302 303 304 305 306 307 308	

Use this space to ask for tear sheets and other information. .....

112 High Speed Reduction Gears — Built-in or coupled reduction gears for mechanical turbines are presented in 8-pp Bulletin H-19. Construction details of both types are shown, and design and material specifications included. Also provided are an application guide chart and dimensional data. Elliott Co.

114 Bearing Lubrication Tips — Everyday problems of bearing lubrication and maintenance are treated in 8-pp Form 426. Although dealing specifically with manufacturer's own bearings contains practical general information on reasons for lubrication, factors involved in choice of oil or grease, correct use of both types of lubricants. Includes chapter on problems of vertical shaft mounting, as well as illustrations of bearing and housing design. The Fafnir Bearing Co.

115 Hydraulic Cylinders — Bulletin 701, 28 pp, provides engineering and descriptive data on manufacturer's complete line of hydraulic cylinders. Generously illustrated by photos, diagrams and charts explaining the different mounting types and capacities of cylinders up to 1500 psi and 3000 psi working pressure. Lindberg Engineering Co.

116 Hydraulic Actuator — Twelve-pp Bulletin 21 is devoted to the Hydromotor, company's hydraulic actuator designed to provide high torque values through reciprocating rotary power. Explains how the Hydromotor works, shows some of the ways it is used. Full engineering data, construction and operating features included. Schematic applications shown. Hydromotor Div., The Bonnot Co.

ELECTRICAL

117 Motors and Drives — Illustrated Bulletin A-2703 is a quick-reference guide giving capsule data on company's a-c motors from ¾ to 300 hp; heavy duty d-c motors from ¾ to 1000 hp; all-electric adjustable speed drive from a-c circuits, from ¾ to 300 hp; electronic controls and regulators for this motor-drive system; and motor-generator sets, generators, and rotating-type regulators. Functions and advantages of each product are included, also service applications. Reliance Electric & Engineering Co.

118 Right-Angle Gear Motor — Manufacturer's new Type GW Syncrogear, a right-angle gear motor specially designed to protect gear alignment is presented in 8-pp Form 1650. Complete cutaway drawings in full color illustrate cantilever principle of mounting, construction details. Pictures vertical, horizontal and flange mountings available, single- and three-phase. The Type GW is designed for speeds from 20 to 155 rpm, gear ratios to 58:1, ¼ to 3 hp. U.S. Electrical Motors Inc.

119 Duct with Aluminum Bars — Bulletin B-750 presents manufacturer's Bustribution duct with aluminum bus bars, stressing the features of aluminum as an electrical conductor. Also contains the story of how aluminum has been adapted to electrical uses. A chart comparing relative size, weight and performance of aluminum and copper in company's LO-X and Plug-In duct is also featured. BullDog Electric Products Co.

120 Distribution Equipment Manual — Designed as a practical reference handbook on standard materials readily available, Bulletin 49051, 48-pp, provides in brief form ample data and information to enable quick and correct selection for electrical distribution installations. Contents are presented in logical order of line design, starting with conductors, poles and cross arms and carrying through primary and secondary distribution materials to a practical selection of outdoor lighting equipment, concluded by reference data. Line Material Co.

121 Trolley Power Distribution System — Illustrated Bulletin 27 briefly describes new heavy-duty trolley busway electric power distribution systems of 250, 375 and 500 amp, 250 v d-c, 575 v a-c, single and three-phase. Construction details are pictured, advantages discussed. Feedrail Corp.

122 Switches for Outdoor Use — Bulletin 5207 describes manufacturer's line of B-2P high capacity switches for outdoor service and is illustrated with photos, diagrammatic drawings and tables. Heavy duty switches described utilize high pressure contacts at clip and hinge ends. Delta-Star Electric Co.

123 Electrical Contact Rivets — Discussed in 6-pp Catalog C-521 are contact rivets made from fine silver, coin silver, silver alloys, palladium, and powdered metal compositions. Standard sizes of flat, crowned and pointed contact rivets also listed. Gibson Electric Co.

124 Magnetic Amplifiers — The first line of Magamp magnetic amplifiers produced by this company is described in 18-pp Booklet TD-52-600. Defines magnetic amplifier terminology and explains the theory of operation. Curves, tables and wiring diagrams are used profusely throughout the sections dealing with component parts, applications. Westinghouse Electric Corp.

Another post card is provided for your use on pages 131-132

COOLING, AIR CONDITIONING

126 Mechanical Draft Cooling Towers — Eight-pp Bulletin 47-A features cooling towers of the single and double inlet squirrel cage blower type, and also provides data on towers of the horizontal induced draft fan type. Sections dealing with the squirrel cage blower type contain charts showing typical temperature performance data, specifications, cutaway blueprint drawings and a selection table for air conditioning and related applications. Water Cooling Div., Binks Mfg. Co.

127 Packaged Air Conditioners — Specification Sheet C-1100-S81 describes two packaged air conditioning systems, one of 10-ton and the other of 15.5-ton capacity. Tells features, includes specifications for the systems which are designed for cooling, dehumidification, ventilation, circulation, cleaning (and heating if desired). Worthington Corp.

128 Water in Air Conditioning Systems — Presented in question-and-answer form, this 2-pp bulletin

(*Continued on page 131*)

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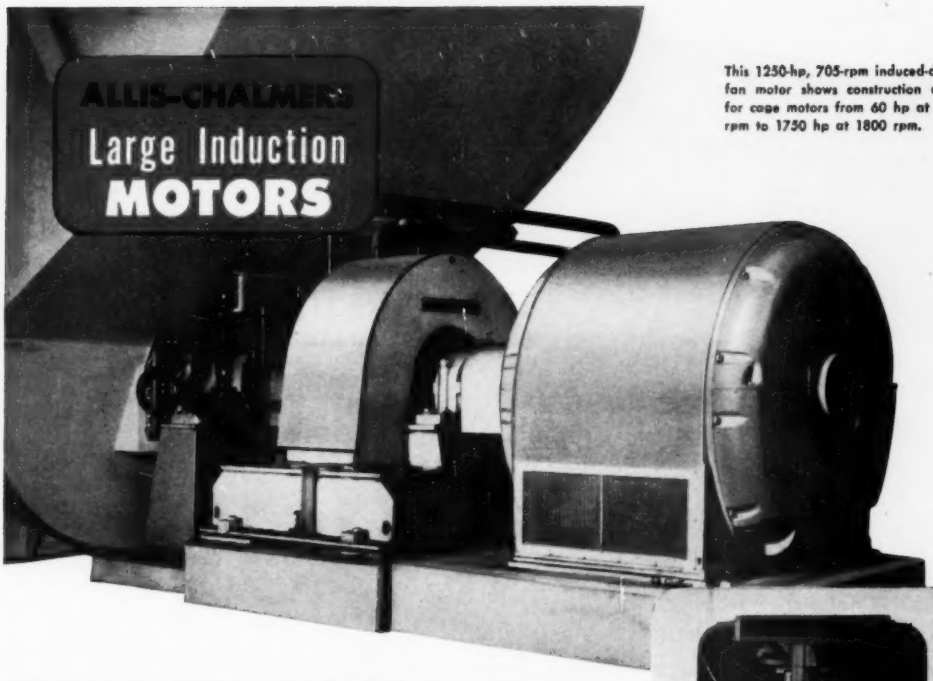
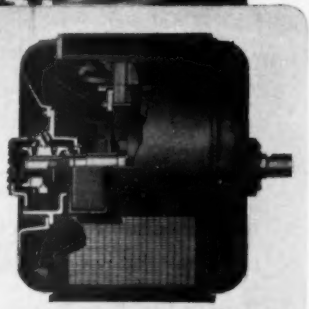


This 1250-hp, 705-rpm induced-draft fan motor shows construction used for cage motors from 60 hp at 300 rpm to 1750 hp at 1800 rpm.

GOOD TO LOOK AT...
and Worth Looking Into

THIS MODERN Allis-Chalmers cage motor looks good in modern power plants—one glance at its clean, simple lines and smooth contours tells you that. But only a careful check of its design features can show how much it offers in all-around protection, easy accessibility, and operating dependability.



Cutaway view indicates construction features of this modern motor. For details, ask your A-C representative for Bulletin 05B7542, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

Protection begins with drip-proof construction as standard above 500 rpm. (Splash-proofing entails no change in external appearance.) In addition, louvers on air discharges and design of intakes keep foreign objects out of the motor.

Accessibility starts paying dividends during installation; large stator air discharge openings allow ample room for drilling, doweling and bolting. And they encourage cleaning of air passages back of the stator core. For cleaning or inspecting the windings, only the upper halves of the end shields need be removed — there's no need to disturb the bearings.

Dependability stems from rigid cast-iron end shields that assure maintenance of correct bearing alignment. Capsule-type bearing housings protect the bearings and oil supply while the motor is being cleaned. And other construction details further uphold the reputation for long-life reliability enjoyed by Allis-Chalmers motors. A-3828

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

For more data circle 527 on Post Card

Could You Use SAVINGS *Like These?*

40% less
Fuel Consumption
50% more
Boiler Capacity

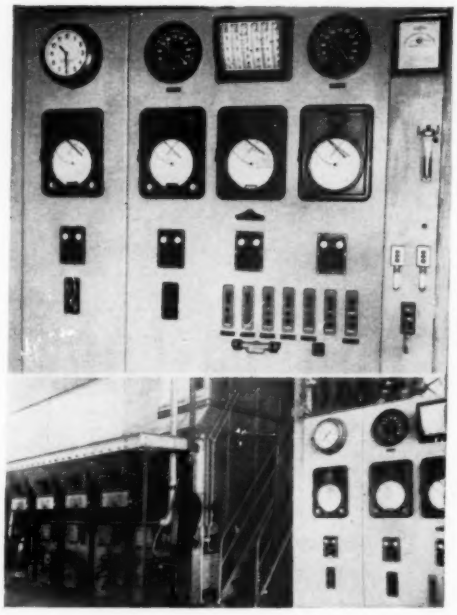
Bailey Meters and Controls Insure Savings at Kerr Bleaching & Finishing Works, Concord, N. C.

The key to complete returns on any investment in new power equipment is a fully co-ordinated system of meters and controls. It's the old story, the tail that wags the dog—careful attention to this comparatively minor part of the over-all installation cost can mean the difference between profit and loss in operation.

Here's where Kerr Bleaching & Finishing Works has cut operating costs—by installing *co-ordinated* Bailey Meters and Controls. The installation includes Bailey Meter Combustion Control, and Bailey Two-element Feed Water Control.

Such a co-ordinated system is an important plus for Bailey customers. Nowhere else can you buy such a complete range of equipment, selected without bias to do the best job for you. Nowhere else can you find such expert engineering service, immediately available through conveniently located direct sales and service representation. May we help you?

Call our local branch office or write for Bulletin 15-H. A-113



Control panel, showing completely co-ordinated Bailey Meters and Controls at Kerr Bleaching and Finishing Works, Concord, N. C.

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

For more data circle 528 on Post Card

Typical of the outstanding steam turbines lubricated with Gulfcrest Oil: 182,000 kw General Electric turbine—the world's largest single-shaft unit—at the Richmond Plant of the Philadelphia Electric Company.

Just RIGHT for every steam turbine —GULFCREST OIL

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the RIGHT background of performance

Gulfcrest Oil has a background of successful performance in every type and make of steam turbo-generator.

In many of these installations the original charge of Gulfcrest has been in service more than 10 years with no significant change in its original characteristics, and with neutralization numbers always remarkably low and safe.

To get this kind of lubrication for your turbine, call in a Gulf Sales Engineer and ask him to recommend the proper grade of this superior oil for your turbine. Write, wire, or phone your nearest Gulf office today.

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GULF INDUSTRIAL LUBRICATION

For more data circle 529 on Post Card

Equipment News

SUMMARIZED HERE are new products and improved ones . . . recent developments of leading manufacturers who will gladly supply further information at no cost. You may use the no-obligation, postage-free cards on pages 37 and 131 for your request. Just circle the numbers of the items you'd like to know more about

1—THROWOVER DEVICE

Automatic control device for the transferring of electric circuits

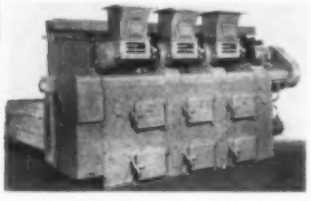
This automatic throwover panel is designed to transfer electric circuits to an emergency power source when the normal source fails. It is applicable for lighting, signal or communication systems, exit markers, regulating and metering equipment, fire protection apparatus and the like, to transfer such circuits to a standby power source when the regular supply is interrupted. Although relative newcomers in the field of safety devices, throwover controls in public buildings are required by law in some states.

This one consists of mechanically interlocked normal-source and emergency-source contactors, and a pilot contactor. Besides transferring circuits to an emergency source and back again upon resumption of regular service, these contactors also serve to control standby power equipment, such as an auxiliary generator, turning it on and off at appropriate times. The standard line of throwover panels, size 1 to 3, use vertical-lift contactors, and sizes 4 to 6 use clapper-type contactors. Control Dept., General Electric Co.

2—SPREADER STOKER

Is designed to provide smokeless operation on the light loads

This stoker is announced as offering to spreader stoker users the continuous cleaning benefits for small and medium sized units from approximately 100 rated boiler hp to 75,000 lb of steam per hour. The continuous cleaning feature



of this new Type CC Rotostoker is provided by a reciprocating grate, the alternating sections of which are fixed. Proper agitation of fuel bed keeps it porous and at the same time avoids blow-holes or dead spots. Ample furnace turbulence is provided by a combination over-fire air and cinder return system. Detroit Stoker Co.

3—MAT SWITCHES

Can be used on floors, platforms and stair treads

A new line of Switchmats — extended area electrical switches in the form of sheets or thin mats — includes sizes and shapes from 2 by 2 in. to 36 by 144 in. The SPST switches are actuated by predetermined pressure ranging from a few ounces to several tons, without obstructing foot or vehicle traffic. Foot pressure on any part of the area covered by the mat closes the circuit, company explains, and release of pressure opens it.

Mats are hermetically sealed against moisture or weather. They are designed to handle up to 1 amp at 110 v directly, and control the operation of high voltage current devices when used in conjunction with control boxes manufactured by this company. Typical uses of the mats include actuating automatic door operators, entry alarms, automatic yard lighting, interplant traffic control signals. The Recora Co.

4—HYDRAULIC GOVERNOR

For universal application to all types of diesel engines

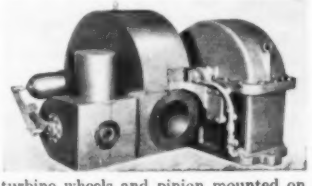
Conventional governor principles plus several new features characterize this control. It has five readily accessible adjustments designed to eliminate the need for changing parts to adapt the unit to the particular requirements of an engine. A self-contained oil supply and new system of by-pass porting and subsequent elimination of accumulators are said to avoid pressure exhaustion and permit effective governing under all speeds and load conditions.

The outer case is finned aluminum. A linkage arrangement using expansion differentials is incorporated to provide for automatic adjustment to temperature changes. Two needle valves provide adjustment of recovery time on acceleration and deceleration. Other announced features include a by-pass type pilot valve designed for greater sensitivity and an adjustable auxiliary valve which may be operated manually, by solenoid or by other means for shut-down. This valve serves the triple function of adjusting servo-piston speed, acting as by-pass valve to provide load limiting and providing shut-down of engine. Dale Hydraulic Controls, Inc.

5—REDUCTION GEARS

High speed types, designed for mechanical drive turbines

These new reduction gears are available in built-in or coupled designs. The built-in gears include company's turbine and gear case firmly secured together, with



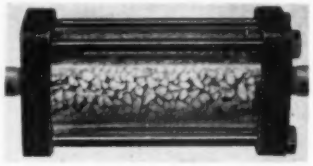
turbine wheels and pinion mounted on the same sturdy, high-speed shaft. This eliminates exhaust-end bearing and coupling, permitting a compact unit of minimum over-all length, company points out. The coupled design is a self-contained gear unit which is flexibly coupled to a separate turbine drive.

Both designs feature precision hobbed double helical gears, liner-type sleeve bearings and self-contained forced feed lubrication system. Offered in gear ratios up to 5:1 for built-in units; up to 8.5:1 for coupled units. Elliott Co.

6—AIR LINE INDICATOR

Shows presence or absence of moisture or water vapor

For use in air or gas lines, this unit consists of a pyrex glass cylinder filled with moisture-sensitive blue granules, and has end plates tapped for ¼ in. pipe. It



is placed in the line between the air supply and the point at which the air is used. The granules stay blue as long as the air leaving the indicator is dry, and turn pink when it contains moisture or water vapor.

Four tie rods protect the cylinder and permit disassembly for recharging with dry granules. Units with glass cylinder are factory tested at 100 psi, and indicators with clear plastic cylinders can be furnished for higher pressures. The indicator is 5 in. long by 2⅝ in. square. Pressure drop is given as less than 1 in. of water at a flow rate of 5 cfm. Bulletin 323 describes the moisture indicator. King Engineering Corp.

7—POWER SUPPLY

Features one regulated B supply, one unregulated filament supply

Excellent regulation, low ripple content and low output impedance are said to distinguish this voltage regulated power supply, the Model 141. The B supply is continuously variable from 100 to 400 v and delivers from 0 to 150 ma. In this voltage range the output voltage variation is less than ½ per cent for both line fluctuations from 105 to 125 v and load variations of minimum to maximum currents. The unregulated filament supply is 6.3 v, 10 amp, center tapped and ungrounded. Designed for relay rack mounting or bench use, the unit is 7 in. high, 19 in. wide and 13 in. deep. Kepco Laboratories, Inc.

8—VOLT-AMMETER

Is pocket-sized instrument with nine ranges to 300 amp, 600 v

Several advanced engineering and design features are incorporated in the new Amprobe 300, latest of company's snap-around volt-ammeters. This one instrument covers the ranges of 0–6/15/30/60/150/300 amp a-c, 0–150/300/600 v a-c. Voltage leads have a new retractable safety plug designed to automatically insulate itself when removed from the meter. Jaws are insulated down into the sockets, and probe jaws are pointed for working in crowded switch and terminal boxes. The Amprobe 300 costs $49.50, complete with leather case and voltage test leads. Pyramid Instrument Corp.

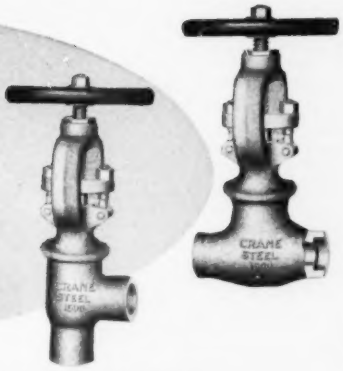
NEW CRANE

SMALL STEEL VALVES

WITH *REVOLUTIONARY* LIP-SEAL
(PATENTED)

BONNET JOINT

1500 AND 2500-POUND CLASSES



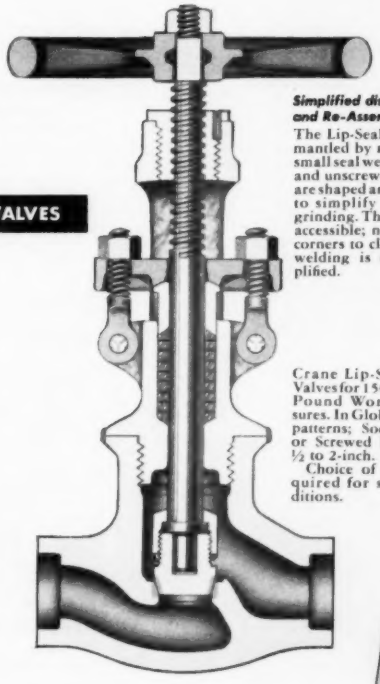
Look closely at the Lip-Seal Bonnet joint of this new Crane small steel valve. A small bead of weld metal seals the joint against leakage—yet the entire mechanical load, both pressure and stem thrust, is carried by strong threaded members.

Here is bonnet joint improvement that brings you important benefits beyond tight sealing and freedom from maintenance.

For example, Crane Lip-Seal design permits a weight-saving, more compact structure without sacrificing strength or reducing seat area. It combines significant developments for improved flow control, ease of operation, and durability. Add to these the ease with which the Lip-Seal joint may be dismantled and re-assembled—and you have a valve with outstanding suitability for your high-pressure/high-temperature power service needs.

DESIGNED AND TESTED TO GIVE YOU:

- **Absolute Tightness**
- **Freedom From Bonnet Joint Maintenance**
- **Minimum Weight and Bulk**
- **Easier Dismantling and Re-Assembly**



Simplified dismantling and Re-Assembly

The Lip-Seal joint is dismantled by removing the small seal weld on the lips, and unscrewing. The lips are shaped and positioned to simplify removal by grinding. They're entirely accessible; no pockets or corners to clean out. Re-welding is equally simplified.

Crane Lip-Seal Bonnet Valves for 1500 and 2500-Pound Working Pressures. In Globe and Angle patterns; Socket-welding or Screwed Ends. Sizes: ½ to 2-inch.

Choice of Steel as required for service conditions.

YOU GET FEATURES LIKE THESE IN LIP-SEAL VALVES

SWIVEL DISC-STEM CONNECTION—Minimizes vibration—provides long pilot guiding for disc. Design makes a more rigid—yet swivel-free—connection.

FULLY GUIDED STEM—Smoother, easier to operate. Fully guided by long yoke bushing and long engagement with lower end of bonnet. Gives positive, straight-line seating.

TWO-PIECE BALL-TYPE PACKING GLAND—Assures uniform load on packing. Prevents binding on stem even when nuts are not pulled up equally.

DURABLE PLUG-TYPE DISC—Has wide seating contact not easily damaged by foreign matter or by wiredrawing. Taper of disc permits close flow regulation while throttling.

STELLITE-FACED SEATING SURFACES—Effectively withstand corrosion and erosion; highly resistant to wear, seizure, galling, and abrasion. Seat is integral with body.

EASY ACCESS TO STUFFING BOX—Ample space within yoke legs allows convenient re-packing. The swinging type gland eye-bolts swing completely clear.

This Circular Ready For You

Your copy of this 8-page booklet supplied free on request. Gives complete information on Lip-Seal Valves, including materials, service recommendations, sizes, and dimensions. Ask your Crane Representative for a copy or write direct.

The Complete Crane Line Meets All Valve Needs. That's Why,
More Crane Valves Are Used Than Any Other Make!

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

For more data circle 530 on Post Card

9—PLASTIC PACKING

Is developed to resist acids, caustics, "problem" solvents

This extruded Teflon packing for difficult applications is reported successful for use in centrifugal pumps handling acids, caustics and hard-to-handle solvents, operating at speeds from slow to 3500 rpm and higher. Called Teflon Plastic Packing 403, it is composed of shredded Teflon and blue asbestos, combined with suitable binders and lubricants, extruded into an open cotton yarn jacket. Packing Div., Flexrock Co.

10—GEAR MOTOR

Built in three pieces to permit quick removal of stator

Designed to simplify maintenance in case of electrical failure of the stator, this new motor is built in three pieces for easy removal of defective stators without disturbing gear components or gear connections to the load. Its design incorporates company's Tri-Clad motor, a compact planetary gear, and a mechanical adapter. The gear is available in speed ratings of 780 to 13.5 rpm. The adapter serves the triple function of acting as the pulley end-shield for the motor, the motor end-shield of the gear housing, and a mechanical spacer for easy accessibility to stator frame bolts.

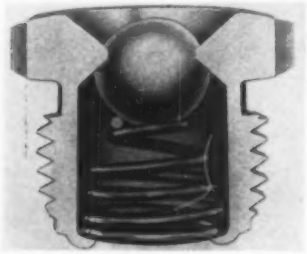
The stator can be changed with the removal of only bearing enclosure screws, the bolts holding the front end-shield to the stator, and those holding stator to the motor adapter. A defective stator can be replaced by another round-frame model, or by a standard-motor stator with feet (mounted upside down so as not to interfere with gear-motor feet).

In the new three-piece construction, openings for ventilation are at the bottom. The motor is available in ratings of 1 to 75 hp for standard applications, up to 200 hp for special uses. Small and Medium Motor Dept., General Electric Co.

11—GREASE FITTINGS

Flush type, for use where protruding fittings are undesirable

The problem of protruding heads of grease fittings being knocked off by a heavy blow or collision is remedied by this new line of flush-type grease fittings, according to manufacturer. They are



made with a ball check. Supported by a spring, the ball prevents oil or grease leakage caused by back pressure. The ball, which holds the opening normally closed and cannot be unseated, is depressed for oiling or greasing, company explains, and the back-up spring is designed so passage through it at point of fullest depression is greater than the opening at the top of the fitting, to provide for free flow of lubricant. Universal Lubricating Systems, Inc.

Want more details on these new products? Use the post cards provided on page 131

12—IMPROVED WRENCHES

For use on a broader range of flanges and couplings

Head walls have been reproportioned to improve the efficiency of these structural box and offset striking-face box wrenches. Proportionately thinner head

walls permit their use on a broader range of American Standard bolted flanges and flanged couplings. In making this improvement no sacrifice has been made in the usable life of these wrenches, manufacturer points out. J. H. Williams & Co.

13—HEXANGLE TEMPLATE

For technical illustrations, saves time drawing hex-nuts

The 121 Hexangle Template, a real time-saver in drawing hex-nuts and hex-head screws in various elevations, features 103 cutouts covering six screw sizes from No. 10 to ½ in., and six elevations: 90, 60, 45, 30, 15 and 0 deg. Cutouts are arranged so that not only the hexagon shapes, but the chamfer circles and flats of the nuts can be drawn. This template is made of plastic, is 8½ by 5¾ in. in size, costs $4.00. RapiDesign, Inc.

14—METALLIC JOINT SEAL

For removal of clean-out plugs, and as anti-seize compound

Compound 411 is described as a pure metallic lead pipe thread lubricant and sealer for general plumbing use. Company says it consists of not less than 63 per cent metallic lead plus 10 per cent non-abrasive filler suspended in a non-volatile hydrocarbon vehicle. It is claimed to be impervious to air, water, steam, oils, ammonia and hydrocarbons, and satisfactory for use in joints or on any threaded fittings. A sample and descriptive bulletin are offered. Armite Laboratories.

15—REVERSIBLE PUMP

Operates equally well when rotated in either direction

The Model CAY was designed primarily for circulating cooling water in air compressors, diesel and gasoline engines, and other water-cooled equipment. Advantages are said to include easy installation in any position on a machine, simplified piping design and adaptability to any type of drive. This pump is suitable for heads up to 50 ft and capacities to 67 gpm. It is fitted with two pre-lubricated ball bearings and has a mechanical seal said to eliminate stuffing box leakage. Gardner-Denver Co.

16—HOOK-ON VOLT-AMMETER

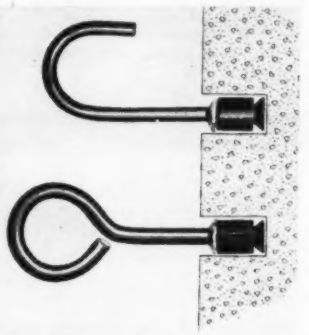
Higher voltage-current ranges, new pointer-stop mechanism

The Type AK-1A is a redesigned hook-on instrument for measuring alternating current instantly on five scale ranges: 0–7.5/30/75/300/750 amp. It can be used on both insulated and non-insulated conductors simply by hooking it around the power line. This instrument will also measure a-c voltage on three ranges: 0–150/300/750 v. To use these ranges, the terminals are connected to the line and a positive action selector switch turned to the desired scale. The pointer-stop mechanism is designed to let the user quickly determine peaks in motor starting currents. Meter and Instrument Dept., General Electric Co.

17—ANCHORING ASSEMBLIES

Pipe bolt and eye bolt, for holding pipe, conduit and guy wires

Both of these anchoring assemblies are claimed to provide 50 per cent greater anchorage in masonry. The pipe bolt assembly is intended for mounting conduit, gas and water pipe, and the eye bolt assembly for anchoring guy wire. The rust-proofed assemblies consist of bolt, lead sleeve, and cup-shaped steel anchor. After insertion in masonry, the lead sleeve is mushroomed out by repeated blows on a special tamping tool. Continuing blows flatten out the steel anchor driving its ribbed steel edges into



the walls of the hole. The steel anchor reinforces the lead sleeve.

The pipe bolt assembly can be obtained for ½, ¾ and 1 in. pipe; the eye bolt assembly can be had in bolt lengths to 6 in. with a 2-in. dia hole. Super-Grip Anchor Bolt Co., Inc.

18—HYDRAULIC VALVE

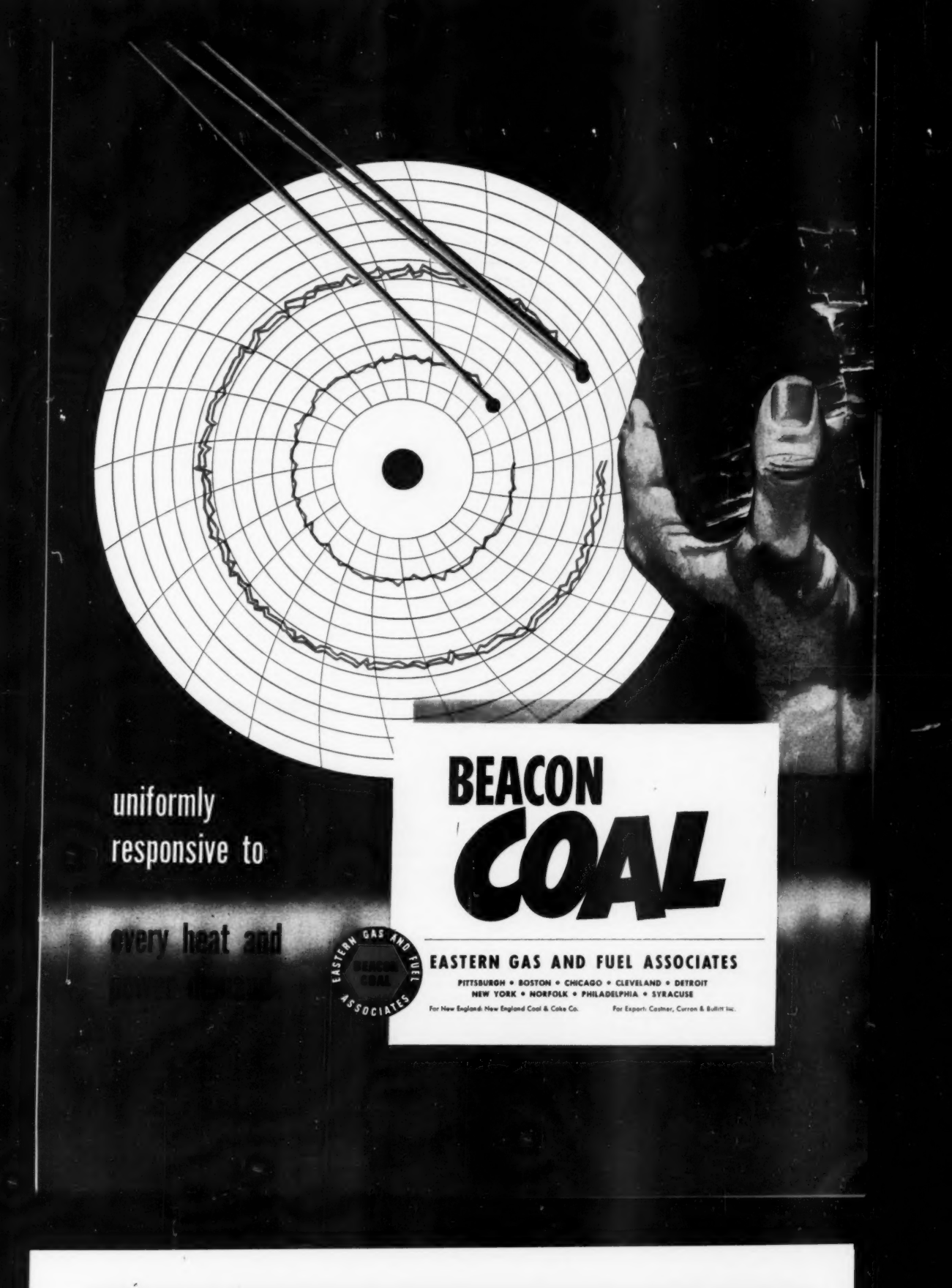
Is designed to open quickly at extreme low temperatures

This new hydramotor valve is said to open fully in 1 min even at – 65 F. It will be available in sizes up to 6 in. with pressure ratings from 2 in. at 600 psi to 6 in. at 65 psi with good flow characteristics and a minimum of flow pressure drop. According to company, the valve will operate for any flowing medium and will be available for remote or manual control. General controls Co.

19—HEAVY DUTY CUTOUTS

Are made available with higher interrupting ratings

These cutouts, rated 5.2 kv, 100 and 200 amp, are designed to interrupt short-


uniformly
responsive to
every heat and
BEACON
COAL
EASTERN GAS AND FUEL ASSOCIATES
PITTSBURGH • BOSTON • CHICAGO • CLEVELAND • DETROIT
NEW YORK • NORFOLK • PHILADELPHIA • SYRACUSE
For New England: New England Coal & Coke Co.
For Export: Castner, Curran & Bullitt Inc.
EASTERN GAS AND FUEL ASSOCIATES
BEACON COAL

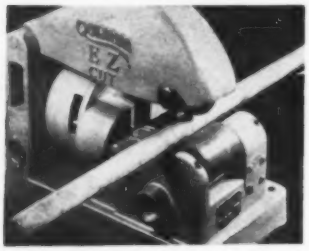
circuit currents of 8000 amp at 5 kv and 12,000 amp 2.5 kv. Interrupting ratings of the superseded cutouts were 8000 amp at 5 kv and 5000 amp at 2.5 kv. Company says the new 100-amp heavy duty cutout can be distinguished from standard duty cutouts by the reflector on the cutout door, which is visible from the ground, day or night. Distribution Transformer Dept., General Electric Co.

20—PIPE CUTTER

Portable unit for fast cutting of pipe, tube and conduit

The E-Z Cutter features power driven rollers which revolve around the pipe, company says, so that cutting is continuous and slippage eliminated — and the high speed tool steel cutter doesn't wear in one spot, so that a single sharpening gives thousands of clean, fast cuts.

The cutter will handle pipe from ¾ to 2 in. and tubing from ⅝ to 3 in.



Adjustable roller type pipe supports handle any length and size of pipe to cut, and a convenient foot control switch leaves the operator's hands free to handle the work. Weight of the cutter is 100 lb. Quijada Tool Div., Gaines-Collins.

21—ALUMINUM PAINT

Is improved anti-rust coating for protecting metal surfaces

PCA-102 Aluminum is made of doubly pigmented aluminum mixed with a clear base vehicle which is identical to company's PCA-101, sold for many years as a clear rust inhibitive. Because of this base, the new paint can be applied quickly without possibility of the base "bleeding" through, company says, and this clear base also provides a brighter appearance and permits better "leafing" of the aluminum flakes to form a moisture-proof coating.

PCA-102 Aluminum may be applied by brush or spray right over rust without priming, scraping, wire brushing or sandblasting. It is reputed to penetrate rust layers and seal the base metal against further rust action and to be equally effective as a rust preventive when applied over any kind of new metal surface. Paint Corp. of America.

22—FLOORING COMPOUND

Cold-setting, for repairing and resealing wood block floors

Blockset is said to seal block floors tightly and form a smooth surface which withstands heavy traffic. It does not require heating and is claimed to eliminate danger from fire and fumes.

According to manufacturer, Blockset dries quickly and when dusted over with silica sand, can be trucked over immediately; also, because it is waterproof, it prevents moisture from penetrating cracks and prolongs floor life. The Monroe Co., Inc.

Want more details on these new products? Just circle the item numbers on the handy new-type post cards on pages 37 and 131

23—HEAT EXCHANGER TUBES

Welded aluminum, offer economy and corrosion resistance

These new heat exchanger tubes are made by longitudinally butt welding of company's Alclad 3S-H12 aluminum alloy sheet, rather than drawing seamless aluminum tubes. The same process may be used in making tubes for applications other than heat exchangers. In the two standard sizes now available, 1 in. OD with 0.049 in. and 0.065 in. wall thicknesses, welded aluminum heat exchanger tubes are said to cost less than seamless aluminum tubes and substantially less per foot than tubes of other commonly used metals.

These welded heat exchanger tubes have the protective Alclad coating on both the inside and outside surfaces.

Typical tensile strength is reported to be 17,000 psi and yield strength 14,000 psi. Standard lengths of the tubes are 12, 14, 16 and 20 ft, but other lengths between 10 and 24 ft may be ordered. Aluminum Co. of America.

24—OXYGEN ANALYZER

For automatic indication of oxygen in flue or process gas

The Model F-3 is designed for combustion applications in power plants, steel mills, petroleum refineries and cement and ceramic kilns. Manufacturer points out that oxygen is strongly paramagnetic and this instrument measures this magnetic susceptibility by means of a simple physical principle. It is said to be unaffected by gases other than oxygen and its accuracy is given as within 1 per cent of full scale for spans of 5 per cent and greater. Combustion ranges include 0 to 5, 0 to 10 and 0 to 15 per cent and are supplied with a second range of 25 per cent.

Another feature stressed is that any standard potentiometer recorder, controller or pneumatic receiver can be used with the F-3. Arnold O. Beckman, Inc.

25—LINE TYPE PURIFIER

For quickly cleaning up steam, air, gas and vapor lines

Combining increased efficiency with a more simplified design this improved Hi-eF Purifier is said to perform automatically and without moving parts to remove virtually all dirt, oil, moisture and guck, even at extreme velocities and pressures. It removes entrainment through a new stationary centrifugal separating element. Entering vapor is engaged by this element which imparts a controlled but rapid rotational motion to the vapor, throwing solids and water outward to the walls of the purifier from where they are drained. This action is said to occur without an appreciable drop in pressure.

Applications for the unit include cleaning up steam from boilers, removing entrainment from gas lines between and after compressor stages, and cleaning up exhaust steam. Purifier is described as moderately priced; further details given in Bulletin 200. Purifier Div., V. D. Anderson Co.

26—PORTABLE pH METER

Is simply designed and economically priced instrument

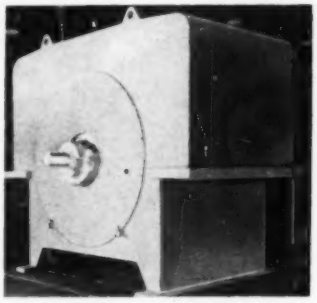
The Model 125 is announced as a low priced battery-operated pH meter of utmost simplicity — it works with only three ordinary radio batteries which give 2000 hr of service. This is credited to advanced designs of subminiature tubes and circuits which also make possible a drastic reduction of the number of electronic components. As a result, company states, the instrument can be offered for $145.00, its operation and maintenance are simplified and accuracy of 0.03 pH is assured. While this meter is primarily intended for battery operation, a stabilized power supply unit can be furnished to operate the instrument from the a-c power line without the use of batteries. Photovolt Corp.

27—OUTDOOR MOTOR

Is built to provide greater protection against weather conditions

Carrying protection further than the splashproof design, this motor for use in semi-outdoor and outdoor steam electric stations is designed to keep wind-driven heavy moisture out of its windings. Its intake velocity has been reduced to less than 600 fpm, so heavy rain particles cannot be drawn into the motor. Air moves vertically upward through side intakes into an expanded air space to further lower its velocity.

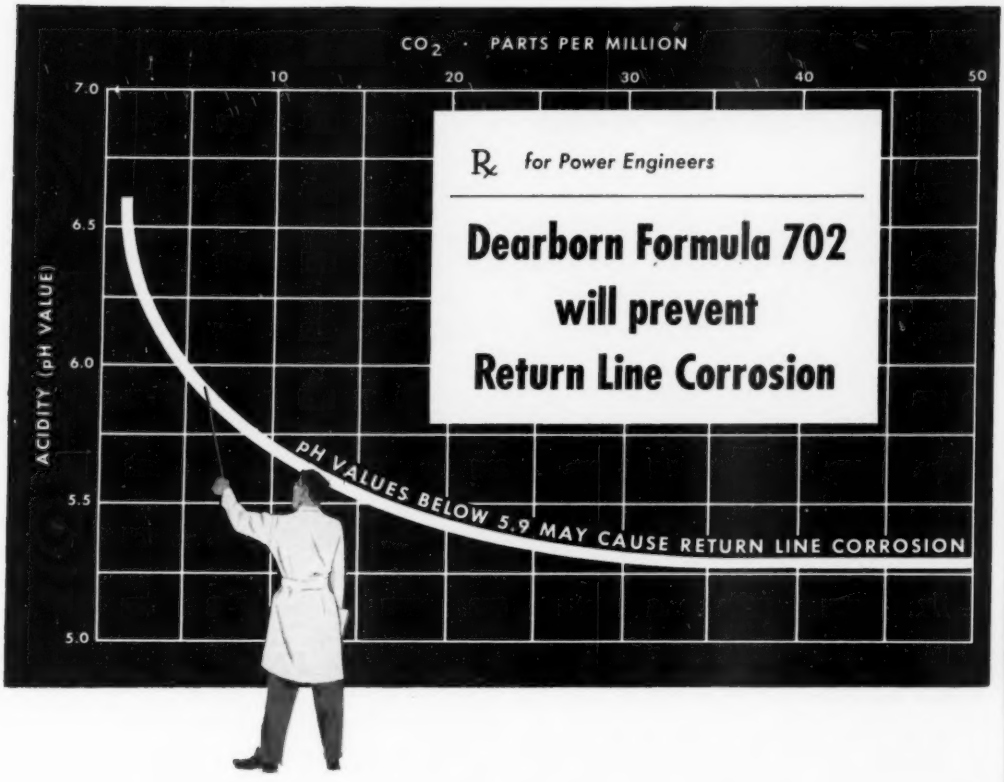
Among protective design details are rain gutters on the sides at the air intakes, which are located at a considerable height above the ground level to keep out dust and dirt during dry weather. Screens over the intake openings serve to keep larger particles such as paper and leaves. The top of the yoke is



slanted slightly to keep water from accumulating in puddles on top.

Ventilating air enters from the sides, around the circumference of the yoke, and makes a right angle turn at the top to go down into the fans at the end of the rotor. Discharge air passes down from stator core into the discharge chamber of the motor yoke directly underneath. During a strong wind, outside air can blow completely through this chamber without getting into the inside of the motor, company points out.

No special concrete foundation or base is required with this motor. It is available in the range of ratings required for major auxiliary drives, including boiler feed pumps. Allis-Chalmers Mfg. Co.



℞ *for Power Engineers*

Dearborn Formula 702 will prevent Return Line Corrosion

What's the pH value of your boiler feed water? Chances are that if it's 5.9 or lower, you have return line corrosion—caused by excessive quantities of dissolved carbon dioxide and oxygen.

Corrosion caused by a low pH is effectively prevented with Dearborn Formula 702. This effective Dearborn treatment, which is introduced directly into the boiler feed water, works three ways. First, it forms a continuous amine film on the return lines to prevent corrosion. Second, this same film improves heat transfer, thus lowering the cost of steam production. Third, Formula 702 will automatically repair the film broken by rust scale separating from the pipe.

It will pay you to learn more about how Formula 702 will reduce excessive maintenance, avoid shutdowns, protect valuable equipment. Why not call your Dearborn Engineer today?

DEARBORN CHEMICAL COMPANY

Merchandise Mart Plaza • Chicago 54, Illinois

BASIC PATENTS

Dearborn holds the basic patents (U.S. Pat. 2400543) for the use of filming amines for treating water.

YOU'LL WANT A COPY OF THIS BULLETIN

Bulletin 5013, which outlines the causes of return line corrosion and the method of cure with Formula 702, will be sent on request.

Dearborn Chemical Company, Dept. P G
Merchandise Mart Plaza
Chicago 54, Ill.

☐ Send a copy of Bulletin 5013
☐ Have a Dearborn Sales Engineer call

Name.....

Company.....

Position.....

Address.....

City.....*Zone*.....*State*.....

Dearborn

TRADE MARK REGISTERED

THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

For more data circle 532 on Post Card

POWER PLANT Construction News

Skagway, Alaska — Aluminum Co. of America, Inc., Gulf Bldg., Pittsburgh, Pa., plans two hydroelectric generating stations in Taiya Valley district, near Skagway, in connection with a proposed new aluminum smelting plant in that area, for which land is being secured. Plant will have a rated capacity of 200,000 tons of aluminum per annum, and will represent a gross investment of close to $400,000,000. It is expected to begin work in 1953, with completion of project in about 48 mos. from that time.

Superior, Ariz. — San Manuel Copper Co., care of Magma Copper Co., Superior, plans power plant in Mammoth-Tiger district, Ariz., in connection with a copper-mining and refining plant development in that area, including a new townsite. A number of buildings will be constructed, with mill, smelter and other units. Cost reported over $20,000,000. Output will be for Government. Proposed to begin work in 1953 and to have mill ready for service 24 mos. later.

Pine Bluff, Ark. — Arkansas Power & Light Co., Pine Bluff, has disposed of a bond issue of $15,000,000, proceeds to be used for expansion and improvements in plants and system, including generating stations, power substations, transmission lines and other operating facilities.

La Habra, Calif. — Beckman Instruments, Inc., 820 Mission St., South Pasadena, Calif., scientific instruments and parts, plans boiler plant at new factory at La Habra, consisting of a main one-story manufacturing building and several smaller structures. Cost estimated close to $2,000,000. Donald R. Warren Co., 3109 Wilshire Blvd., Los Angeles, Calif., is consulting engineer.

Stockton, Calif. — General Mills, Inc., General Mills Bldg., Minneapolis, Minn., flour, cereal products, animal feed, etc., plans boiler plant at proposed new feed mill at Stockton, where site has been selected. It will comprise a main processing and production building, and several smaller structures. Cost reported in excess of $500,000.

Montville, Conn. — Connecticut Light & Power Co., 36 Pearl St., Hartford, Conn., has plans maturing for expansion and improvements in steam-electric generating plant at Montville, with installation of new turbine-generator, high-pressure boiler and auxiliary equipment. Cost reported about $15,000,000. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is consulting engineer.

Gainesville, Fla. — Municipal Water, Light & Power Dept., plans extensions and improvements in municipal steam-electric power plant, with installation of additional equipment for increased capacity. Cost estimated close to $1,500,000.

Orlando, Fla. — Orlando Utilities Commission, 102 Wall St., has approved plans for extensions and improvements in municipal steam-electric generating station, with installation of additional equipment. Cost reported over $500,000. Work will be carried out at once. Robert & Co., Associates, 96 Poplar St., N.W., Atlanta, Ga., consulting engineers.

Bedford Park, Ill. — Corn Products Refining Co., 17 Battery Pl., New York, N. Y., syrups, corn oils, dextrine, etc., plans boiler plant at new mill at Bedford Park, to cost about $2,500,000, with high-pressure boilers and auxiliary equipment. Sargent & Lundy, Inc., 140 South Dearborn St., Chicago, Ill., is consulting engineer. Entire project, comprising several units, will cost close to $6,000,000, in addition to power house. Vern E. Alden & Associates, 120 South LaSalle St., Chicago, is engineer for plant.

Greencastle, Ind. — International Business Machine Corp., 590 Madison Ave., New York, N. Y., accounting machines and parts, typewriters, etc., plans boiler plant at proposed new factory at Greencastle, for manufacture of cards and forms for use on company machines. It will consist of a main one-story building and several smaller structures. Cost reported about $3,500,000. Giffels & Vallet, Marquette Bldg., Detroit, Mich., is architect and engineer.

Crystal Falls, Mich. — Municipal Light & Water Dept., City Hall, plans installation of a new 400-kw hydraulic turbine unit and accessories, in connection with expansion in municipal hydroelectric generating plant, recently noted in these columns. Holland, Ackerman & Holland, 20 North Wacker Dr., Chicago, Ill., are consulting engineers.

Columbus, Miss. — Oldbury Electro-Chemical Co., Niagara Falls, N. Y., industrial and other chemicals, plans steam power house at proposed new branch plant at Columbus, where site has been secured. It will comprise several one- and multi-story buildings for processing and general production. Entire project is estimated to cost about $3,500,000.

Kansas City, Mo. — Kansas City Power & Light Co., 1330 Baltimore Ave., plans expansion in new Hawthorn steam-electric power plant, with installation of new 100,000-kw. turbine-generator, high-pressure boiler and auxiliary equipment. Cost estimated about $15,000,000, with transmission lines, substations and other operating facilities. Completion is scheduled in about 35 mos.

Columbia Falls, Mont. — Anaconda Copper Mining Co., 25 Broadway, New York, N. Y., plans power plant in connection with proposed new aluminum metal plant at Columbia Falls, Flathead County, where tract of land has been acquired. Production plant will comprise several large structures. Project will represent a reported investment of about $45,000,000. It is understood that work will begin in 1953.

Lincoln, Neb. — Water & Light Department, 29th and A Sts., plans expansion and improvements in municipal power plant, with installation of additional equipment. Cost reported about $600,000. Proposed to carry out work soon. D. L. Erickson is city engineer, in charge.

Hempstead, L. I., N. Y. — Long Island Lighting Co., Mineola, L. I., is purchasing a tract of land on Anderson Island, Hempstead, to be used as site for new generating station. Installation will include turbine-generators with rated capacity of 160,000 kw., high-pressure boilers and auxiliary equipment. Plant will be designed for installation of additional generators in future. Cost reported about $25,000,000. Plans will be completed soon.

Ithaca, N. Y. — New York State Electric & Gas Corp., Binghamton, N. Y., plans new steam-electric generating station at Heddens, near Ithaca, where tract of about 100 acres of land has been acquired, fronting on Cayuga Lake. It will be equipped for an initial capacity of 135,000-kw., and ultimate rating of 500,000-kw. First unit is expected to be ready for service late in 1954. Cost reported over $15,000,000, with transmission lines, power substations and other operating facilities.

Cleveland, Ohio — Cleveland Electric Illuminating Co., Illuminating Bldg., has authorized expansion in new steam-electric generating station, Eastlake, Ohio, now in course of construction, with installation of a fourth turbine-generator unit of 200,000-kw. rating. First two units of plant, each 125,000-kw. capacity, will be ready for service in 1953, with a third such generator to be installed in 1954. Fourth unit will cost about $25,000,000, with other facilities, and is scheduled for service in 1956. Entire plant will represent a total investment of about $80,000,000.

Yukon, Okla. — Oklahoma Gas & Electric Co., Oklahoma City, Okla., plans expansion in Mustang steam-electric generating station at Yukon, with installation of new 100,000-kw. turbine-generator, high-pressure boiler and auxiliary equipment. Entire project is reported to cost approximately $10,000,000, with power substations, transmission lines, etc. It is understood that plans will be prepared by Pioneer Service & Engineering Co., 231 South LaSalle St., Chicago, Ill., consulting engineer.

Pittsburgh, Pa. — Duquesne Light Co., 435 Sixth Ave., has disposed of a bond issue of $14,000,000, proceeds to be used for extensions and improvements in plants and system, including increased generating facilities, power substations, transmission lines and other work.

Scranton, Pa. — Scranton Electric Co. has disposed of a bond issue totaling $7,500,000, proceeds to be used for expansion and improvements in power plants and system. Company plans new steam-electric generating plant, with capacity of 40,000-kw., with power substations, transmission and distributing facilities.

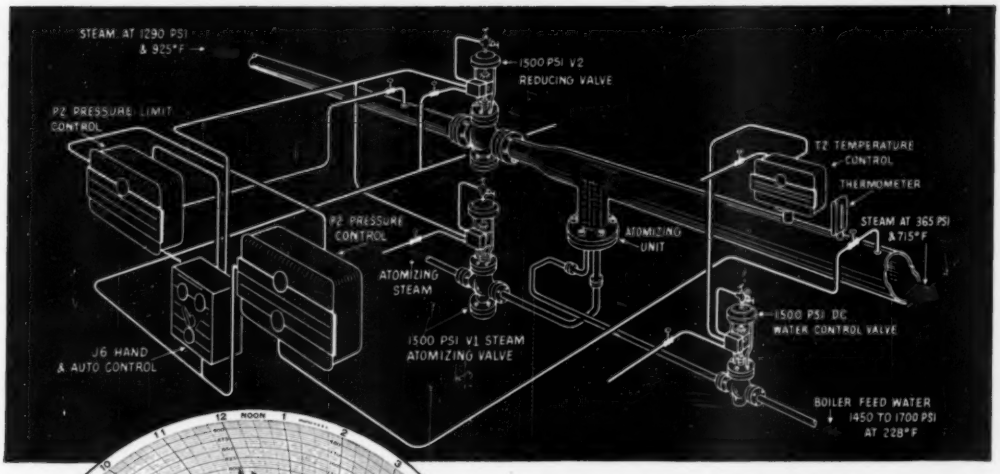
Calallen, Tex. — Central Power & Light Co., Corpus Christi, Tex., has plans under way for new steam-electric generating plant at Calallen, to be equipped for an initial capacity of about 66,000-kw. Cost reported over $5,000,000, with power stations, transmission lines and other operating facilities. Sargent & Lundy, Inc., 140 South Dearborn St., Chicago, Ill., is consulting engineer.

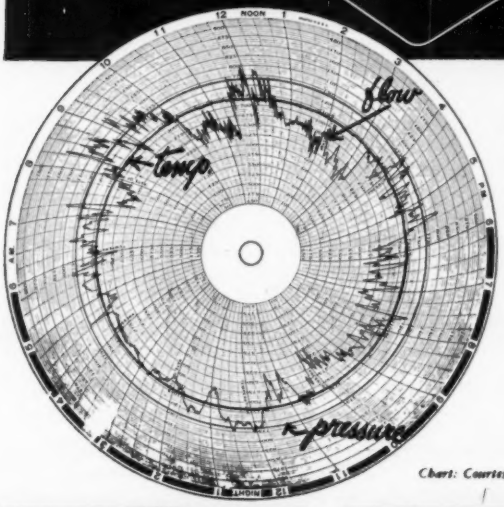
Lone Star, Tex. — Southwestern Gas & Electric Co., Shreveport, La., is reported planning new power plant in vicinity of Lone Star, with installation to comprise a 40,000-kw. turbine-generator, high-pressure boiler and accessory equipment. Cost estimated close to $3,500,000, with power substations, transmission and distributing lines, etc.

Longview, Tex. — Southwestern Gas & Electric Co., Shreveport, La., plans new steam-electric generating plant at Lake Cherokee, near Longview, with initial capacity of about 75,000-kw. Cost reported over $5,000,000, with power substations, transmission lines and other operating facilities.

San Antonio, Tex. — San Antonio Public Service Bd., 201 North St. Mary's St., has completed plans and will proceed at once on extensions in municipal steam-electric power plant on Slado Creek. Installation will include a new 60,000-kw. turbine-generator, high-pressure boiler and auxiliary equipment. Cost reported about $750,000. Gibbs & Hill, Inc., 450 Seventh Ave., New York, N. Y., is engineer and contractor.

Swartwout RDC* controls within ±1 psi and ±3°F even with widely fluctuating load swings


STEAM AT 1290 PSI & 925°F
1500 PSI V2 REDUCING VALVE
PZ PRESSURE LIMIT CONTROL
TZ TEMPERATURE CONTROL
THERMOMETER
PZ PRESSURE CONTROL
ATOMIZING UNIT
STEAM AT 365 PSI & 715°F
ATOMIZING STEAM
1500 PSI DC WATER CONTROL VALVE
J6 HAND & AUTO CONTROL
1500 PSI V1 STEAM ATOMIZING VALVE
BOILER FEED WATER 1450 TO 1700 PSI AT 228°F

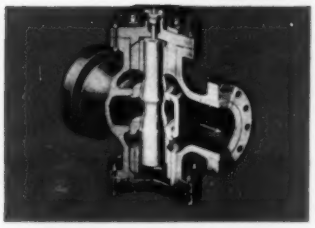


1 Chart shows how Swartwout RDC*—Reducing, Desuperheating and Control System—handles low-pressure turbine load of 65,000 to 165,000 lbs. steam per hour in Des Moines Power Station No. 2 of the Iowa Power and Light Company. It reduces from 1290 to 365 psi and desuperheats from 925° to 715°F. When main reducing valve closes, extremely light loads can be handled by pressure reducing valve supplying atomizing steam. Operation of the system is stable regardless of load change or time lag. Because of the exceptional control obtained by this large station, the Iowa Power and Light Company later purchased an additional small Swartwout RDC unit to supply steam to house turbines.

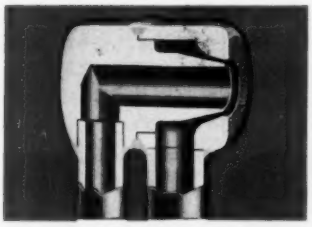
Swartwout

POWER PLANT EQUIPMENT

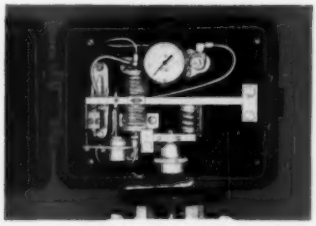
Chart: Courtesy Iowa Power and Light Company



2 Swartwout V-2 Regulating Valve has smooth, nozzle-shaped passages which guide expansion of high-pressure steam to reduced pressure zone without high-velocity impingement or other destructive forces common to conventional valves. Undue noise, turbulence and vibration are eliminated; longer valve life results.



3 Swartwout Steam Atomizing Desuperheater, constructed of stainless steel, has accurately machined passages that give narrow-angle dispersion of cooling water outside of steam atomizing head. There is no impingement of steam or water against walls of unit, no erosion of parts, no need for pipe liners.



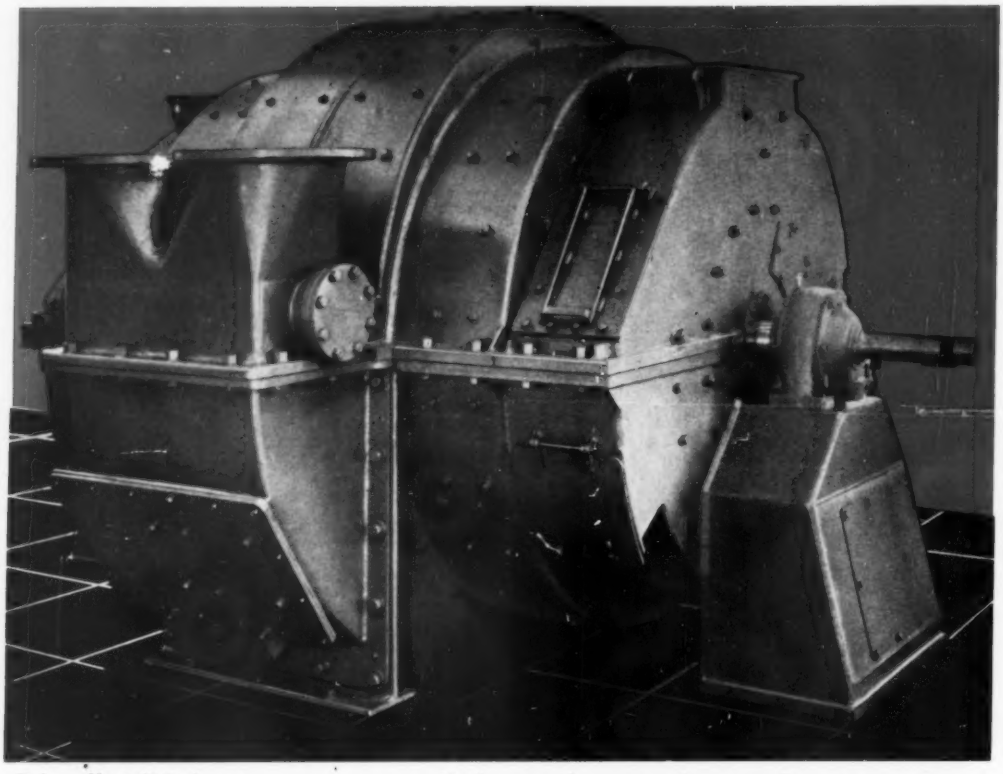
4 Swartwout T-2 Control, with metallic temperature element in steam pipe, gives rapid and precise control regardless of magnitude of load or time lag. There are no flapper valves, relays or other delicate elements. Only two simple adjustments are involved; one for temperature, one for response.

A-5002

SEND FOR BULLETINS S-21-E, S-22-C, S-198 • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

For more data circle 533 on Post Card

Performance of Riley "50" Pulverizers



Riley "50" Pulverizers give you all these other significant advantages . . .

Quiet vibrationless operation
Flexibility—wide load range
Ability to carry extremely low loads
Low power consumption
Ease of regulation

Small space required
Minimum foundation cost
Parts easily renewed
Can be operated without coal feed
Ease of ignition

Low lubrication cost
No worms or gears—Just two bearings
High primary air temperatures
Low maintenance

The Riley "50" Pulverizer is the latest development in the coal pulverizing field. It is the only pulverizer using tungsten carbide parts to assure long periods of continuous operation and low maintenance. It will pay you to investigate Riley "50" Pulverizers when considering this type of equipment.

TRADE MARK Rx REGISTERED

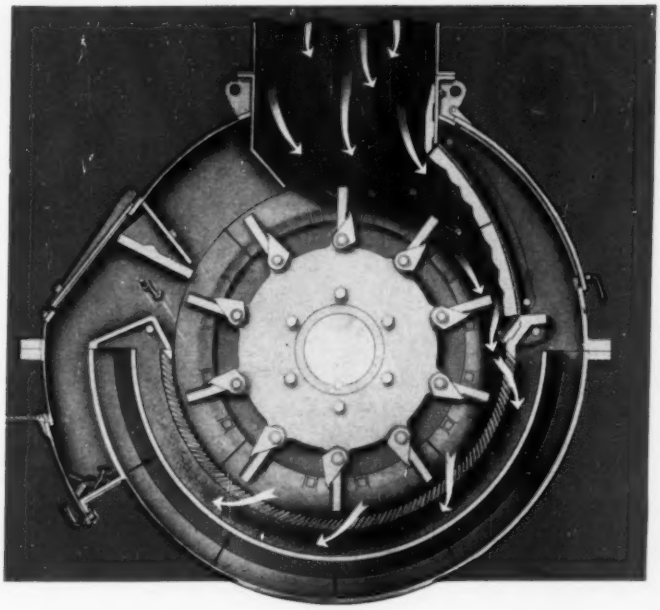
RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Washington Buffalo Pittsburgh Cleveland Detroit Chicago
Cincinnati Charlotte Atlanta New Orleans St. Louis Kansas City St. Paul Tulsa Houston
Denver Salt Lake City Los Angeles Portland Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • ECONOMIZERS

not affected by Increase in Moisture



This Crusher-Dryer Stage Does the Trick

Both field and laboratory tests have conclusively proven that moisture content of coal does not affect performance of Riley "50" Pulverizers and that capacity is not decreased with an increase in moisture provided primary air temperatures are adequate. Coals with free moisture up to 15%, which is about the free moisture limit that coal can retain, have been satisfactorily pulverized.

The ability of Riley "50" Pulverizers to handle such high moisture coals without capacity reduction is due to the performance of the crusher-dryer section of the Riley "50" Pulverizer. In this first stage, the free moisture is evaporated and the coal crushed to a fine granular state so that coal passing to final pulverizing stage is free of surface moisture.

Ask users of Riley "50" Pulverizers—they will tell you that moisture of coal means nothing to their Riley "50" Pulverizers.

All of these people have ordered Riley "50" Pulverizers within the past two years.

PUBLIC UTILITIES
- Detroit Edison Co.
- Iowa-Illinois Gas & Electric Co.
- Monongahela Power Co.
- Utah Power & Light Co.
- Hartford Electric Light Co.
- Public Service Co. of Colorado
- Iowa Electric Light & Power Co.
- Northern States Power Co.
- The Potomac Edison Co.
- Superior Water, Light & Power Co.
- Western Colorado Power Co.
- South Carolina Public Service Authority
- Corn Belt Power Cooperative
- Central Ohio Light & Power Co.

MUNICIPAL PLANTS
- City of Richmond, Indiana
- City of Holyoke, Mass.
- City of Rochester, Minn.
- City of Owensboro, Ky.
- City of Austin, Minn.

INDUSTRIAL COMPANIES
- Carbide & Carbon Chemical Co.
- Goodyear Tire & Rubber Co.
- Western Electric Co.
- General Electric Co.
- Hooker Electrochemical Co.
- North American Aviation
- The Ohio Oil Co.
- National Supply Co.
- Continental Can Co.
- Monsanto Chemical Co.
- St. Croix Paper Co.
- Celanese Corp. of America
- Owens-Corning Fiberglas Co.
- Pittsburgh Plate Glass Co.
- Lowlees Bros. Paper Co.
- U. S. Finishing Co.
- Bell Aircraft Co.
- Syracuse University
- U. S. Steel Company
- Riegel Textile Corp.
- White Pine Copper Co.
- Ciba States Ltd.
- Great Lakes Naval Training Station
- Boston Navy Yard
- Ashland Oil & Refining Co.
- Ruberoid Co.

ENGINEERED BY THE FOLLOWING CONSULTANTS
- Stone & Webster Engineering Corp.
- Ebasco Services
- Sargent & Lundy
- Ford, Bacon & Davis, Inc.
- Chas. T. Main, Inc.
- Sanderson & Porter
- United Engineers & Constructors
- Jackson & Moreland
- Bechtel Corporation
- Pioneer Service & Engineering Co.
- Black & Veatch
- Stanley Engineering Co.
- Douglas M. McBean
- Robson & Woese, Inc.
- Francisco & Jacobs
- Burns & McDonald
- Kenneth R. Warrington
- J. V. Edeskuty
- Robert S. Curl & Associates
- Interboro Company
- Catalytic Construction Co.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

For more data circle 534 on Post Card

How ONE can equal SIX

IN FUEL OIL HEATING

Conventional fuel oil heaters have bare tubes, with practically the same amount of surface inside and outside. But fuel oil requires more heat transfer surface than does the heating steam, because of its considerably lower heat transfer rate. Therefore, the number of bare tubes required for the heat-absorbing capacity of the oil is very much greater than the number which would be sufficient for the heat conductivity of the steam.

The G-Fin heat transfer elements of the G-R Twin G-Fin Section compensate for this difference in heat transfer rates of oil and steam. Their longitudinal fins have a total of more than 6 times as much surface as the interior of the elements. This means that a Twin G-Fin Section will have only 1/6 the number of tubes that would be required by a conventional bare tube heater for the same duty.

Investigate these compact, simple units and their many other advantages for heating your fuel oil. Complete information will be sent without obligation.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

G-R HEAT TRANSFER APPARATUS *Twin G-Fin Section*

For more data circle 535 on Post Card

IMPROVE COAL HANDLING *Three* WAYS...

with VERSATILE ALLIS-CHALMERS TRACTORS

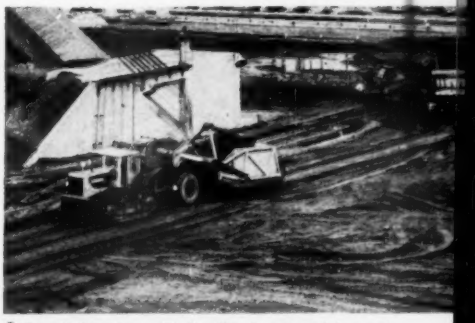
1. **ADD FLEXIBILITY.** Store coal wherever there is available space . . . and reclaim it any time. A-C crawler tractors, equipped with loaders, bulldozers or scrapers travel anywhere . . . over any ground. And in rush periods, you can speed up operations temporarily by transferring additional tractor units to the job.

2. **HAVE EXTRA FIRE PROTECTION.** When A-C tractor units store coal, they spread it in thin layers and compact it by constant travel over the pile. The tight packing of horizontal layers eliminates the flues that cause spontaneous combustion in loose conical piles.

3. **REDUCE EQUIPMENT INVESTMENT.** The Allis-Chalmers tractor method is considerably more economical and flexible than complex conveyor or crane systems — which means savings in original cost as well as lower cost per ton for coal handling. And tractor units can also be used for such jobs as plant and yard maintenance, material handling, car spotting and snow removal.

Send for free booklet, "Economic Coal Storage with Allis-Chalmers Tractors." Describes modern coal-handling methods, using A-C tractors and 'dozer blades, front-end loaders and scrapers. Write Allis-Chalmers Tractor Division.

● HD-5G Tracto-Shovel stockpiling coal at a large industrial plant in Cleveland . . . has averaged 2500 tons a month for a year and a half without ever being down for repairs.



● Four A-C tractors with Gar Wood scrapers bring real flexibility to the coal handling operations of an Ohio utility. They haul as far as 1,700 feet . . . store wherever there is available space.

Four Diesel-Powered Models . . . 11,250 to 41,000 lb.

ALLIS-CHALMERS

TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

STEAM POWER for Kaiser

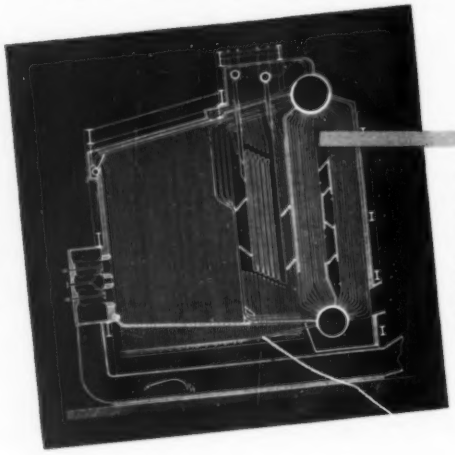
15 FOSTER WHEELER STEAM GENERATORS SERVE THE SOUTH'S BIG NEW

For every pound of aluminum produced in this new 400,000,000 pound-per-year plant, Kaiser will need about 10 kwh of electric power.

To meet this enormous, almost constant demand, Kaiser Engineers selected a plant consisting of gas-burning radial engines, and 15 Foster Wheeler "D" type boilers to supply steam for the turbine-generators.

These boilers, with a combined capacity of 3,375,000 lb of steam per hr, are ideally suited to Kaiser's requirements for reliability, ease of operation and high availability. And they are a natural for use in the South where a temperate climate permits low-cost, semi-outdoor-type installations.

This installation is another example of Foster Wheeler's ability to design and construct power-producing equipment to meet the needs of industry.



Cross-section of one of the 15 duplicate Foster Wheeler "D" type steam generators for Kaiser Aluminum. The regenerative air heater is not shown.

CAPACITY	225,000 lb per hr
PRESSURE	900 psig
FINAL STEAM TEMPERATURE	905 F
TEMPERATURE FEEDWATER INLET	350 F
FIRING	Natural Gas

For information on your steam generation

Aluminum

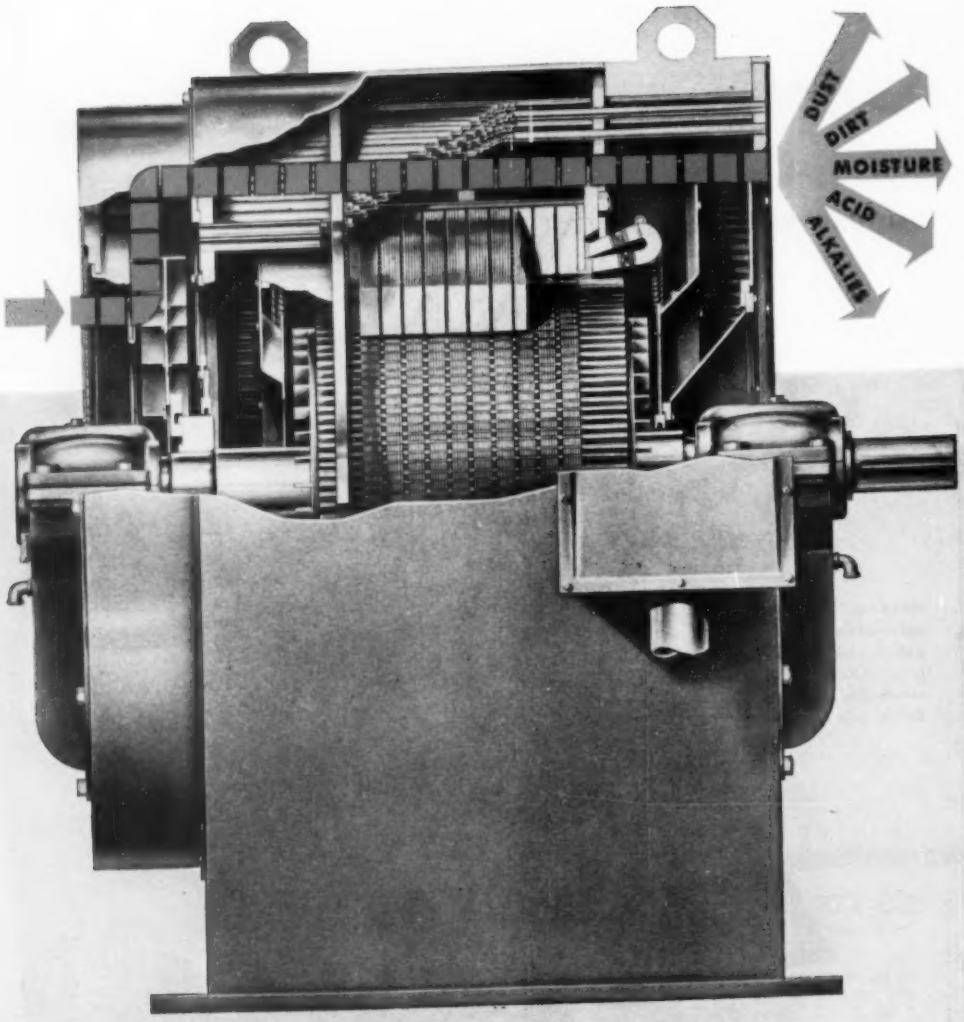
INDUSTRY AT CHALMETTE, LA.

Aerial view showing first six boilers and six of the eight stacks under construction. Nine more boilers, now being fabricated, will be located in extension of the present line. Turbine room is to the left.

requirements, write to: FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, NEW YORK

FOSTER WHEELER

For more data circle 537 on Post Card


DUST
DIRT
MOISTURE
ACID
ALKALIES

Name your motor enemy—

this TEFC Tube Type Motor

licks it!

This totally enclosed, fan-cooled motor does its own house cleaning. It is built to operate under practically any kind of dirty or contaminated air conditions. A simple air-to-air heat exchanger system does the trick.

All electrical parts are totally enclosed in a chamber surrounded by tubes. Fan-driven air rushes straight through these tubes carrying away internal heat—keeping tubes free of foreign matter. Cleaning is rarely needed.

Just what does this mean to you? It means you can install this motor any place. Inside or out—in coal dust, soot, rain, fog or mild acids or alkalies . . . name your motor poison—this motor is built to take it. You get maximum service with minimum maintenance.

Remember, too, this motor includes features that have made Westinghouse Induction Motors leaders in industry. For example: Sectional covers and air shields, easily removed by hand. Split bearing housings, with bearings readily accessible for inspection or replacement. Sturdy welded steel frame; stronger, lighter, smaller.

Get all the facts on this TEFC Tube-type Motor. Westinghouse Tube-type Motors for special applications, installed as long ago as 1937, have supplied a wealth of information to aid you in planning your installation. See your Westinghouse representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-10376

YOU CAN BE SURE...IF IT'S
Westinghouse

LARGE INDUCTION MOTORS

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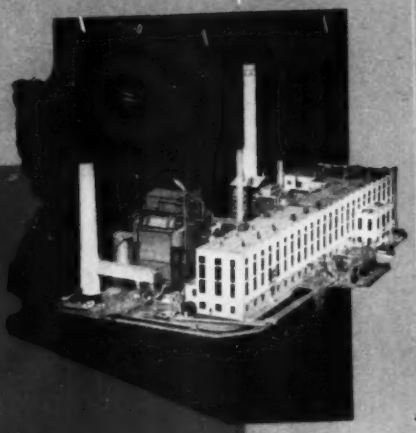
UTAH

VADA

ALSO IN ARIZONA, IT'S YARWAY



PUBLIC SERVICE

PICKS

YARWAY UNIT TANDEMS

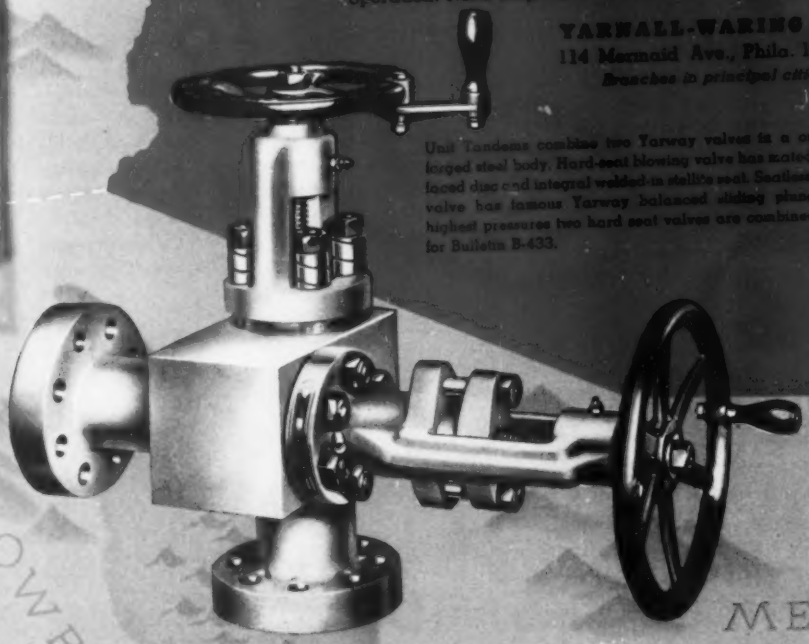
FOR 920 PSI BLOW-DOWN SERVICE

Arizona Public Service Company—operating in the youngest, but one of our fastest-growing states—is another prominent utility that relies on Yarway Unit Tandem Blow-Off Valves to guard its boilers. In fact, *4 out of every 5 high pressure boiler plants are Yarway-equipped.*

Such popularity had to be won. It was—by offering good design, careful engineering and manufacturing, modern metallurgy and dependable service.

Yarway engineers, conveniently located near you, are constantly working for better, more profitable steam plant operation. Need help? Call a Yarway man.

YARNALL-WARING CO.
114 Mermaid Ave., Phila. 18, Pa.
Branches in principal cities



Unit Tandems combine two Yarway valves in a one-piece forged steel body. Hard-seat blowing valve has mated stellite-faced disc and integral welded-in stellite seat. Seatless sealing valve has famous Yarway balanced sliding plunger. For highest pressures two hard seat valves are combined. Write for Bulletin B-433.

NEV

ME

MEXICO

YARWAY SERVICE GOES ALL THE WAY....

LETTERS TO THE EDITORS

Ships and Shoes and Sealing Wax . . .

THE AUGUST issue was of special interest and value in a number of details, particularly in the review of the Wisconsin River situation and associated elements. If only the "voting" public could take its lesson to heart. Senator Wayne Morse reacts unfavorably to the references to lower cost electricity in his area under private ownership than in the subsidized TVA area.

One wonders, concerning the Detroit Lakes situation, whether the addition of capacitors has caused any local voltage rises.

"Engineering Education As a By-Product" was much to the point. When one takes into account the accomplishments in days past with limited facilities, the cut-and-dried robot features of today often do not permit much initiative.

Concerning the Wisconsin River call, I wondered whether Dudley Diggs of West Clox Division at La-Salle, Ill., was a former GE man. He might be the one I knew in the past.

The new electromagnetic pump seems a bit over my head although the fundamentals are quite in order. Perhaps this is another application where a low-voltage high-current unipolar generator could fit in.

Incidentally, there was a typographical error in the reply about connecting phasing transformers 69.3 instead of 6.93, doubtless discovered ere this.

Concerning replies to Question No. 498, I did not notice reference to a feature often installed with such equipment. This was a small hand-operated pump, which was sufficient to keep the pump primed; and each shift operator had this element as a routine chore to attend to. Of course, it would be unnecessary with an available priming supply, but in my experience with a portable outfit the hand pump served as well.

C. O. VON DANNENBERG
Brooklyn, N. Y.

Editor's Note: — *Referring to the electromagnetic pump, it is an interesting gadget and we found out that it is only one variety of electromagnetic pumps that have been developed. This one, of course, is a direct-current pump, since the 20,000 amp at one volt is direct current. They have also developed an alternating-current version which operates somewhat on the principle of a 3-phase induction motor. In that particular development, the liquid metal is virtually screwed through the pipe. In other words, it rotates by virtue of the rotating magnetic field set up by the windings on the outside of the pipe. We don't know too much about this version, but we listened to a verbal description of it by one of the Atomic Energy Commission engineers.*

Incidentally, the source of the 20,000 amp at one volt has created some interest and some of our readers wonder what sort of rectifiers are used to produce this current. We are quite certain that no rectifiers are involved, since practically no rectifier would have a voltage drop low enough to permit such currents. Also, the 20,000 amp could more easily be obtained by means of a direct-current generator.

Thinking this matter over, however, it seems that this perhaps would be a good application for the homopolar generator, which we discussed in our correspondence several years ago.

Centennial Frustration

IN YOUR ARTICLE on the Centennial of Engineering in the September issue you stated that the purpose of the centennial in Chicago this year was to remind our fellow citizens of the factors that have produced our prosperity . . . etc. Undoubtedly this was a noble purpose but one which I am afraid fell far short of achievement.

It was my good fortune to have the opportunity to attend the centennial, and while I found plenty of events to interest me, I was disappointed in the way the centennial as a whole was organized or perhaps I should say the way it lacked organization. Trying to attend the various sessions I wanted to attend was more like a rat race than anything I have engaged in for a long time, indeed, my sheer inability to be at twenty different places at once was frustrating.

There was, of course, a wealth of good technical material available. With some 51 engineering societies and associations holding full scale national technical meetings this was inevitable. The trouble was, there was entirely too much; too many meetings, too many luncheons, too many papers, too many societies, too much to divide attention from the main purpose of the centennial, which was to acquaint the public with what the engineer was doing. As it turned out, the public learned very little about the importance of engineering to society, except those relatively few who were able to attend the stage production *Adam to Atom*. These, however, were largely engineers who already knew what engineering means to society.

The symposium program, the series of meetings around which the centennial was organized, was excellent, at least in its conception. It was built around the basic theme, the enhancement of public appreciation of engineering, and the speakers and the papers they presented were all splendid. The meetings, however, suffered from lack of attendance because of the conflict with meetings of the various engineering societies. At the same time that the symposium meetings were held, there were simultaneous meetings of the various engineering societies, and it was probably only natural that engineers belonging to these societies should attend their own sessions rather than the symposium meetings.

This, in itself, would not have been a serious matter, provided the general public had attended the symposium meetings. But the public did not attend these meetings. The audiences were composed largely of people with engineering interests who managed occasionally to break away from their own society meetings, and frequently, these were only too few. Of the millions of people in the Chicago area, very few were even conscious of the centennial celebration.

It is my feeling that the lack of coordination between the various engineering societies in the centennial program stems from the same isolationist type of policy that makes it unable for the engineering societies to coordinate their efforts into a single unified organization comparable to the American Medical Association. It would have been much more effective, if, in this centennial celebration, the engineering societies had pooled their resources, eliminated some 90 per cent of the technical papers dealing with specialized engineering topics, and organized a series of general meetings which all could attend and each learn something of what other groups are doing. This, of course, was the idea behind the Symposium program.

I make this criticism of the Centennial, not in a derogatory mood but as a plea to the engineering societies to abandon some of their isolationist tendencies and to coordinate their operations so as to better serve both their own and the public interest. There was much about the Centennial of Engineering that was interesting and inspiring. The exhibits at the Museum of Science and Industry were splendid; so were the papers delivered at the Symposium meetings, and the stage production *Adam to Atom* was both interesting and instructive. The trouble was in the conflict of interest produced by the uncoordinated technical meetings of the societies, and in the lack of more definite efforts to gain the attention of the non-engineering public to the Centennial's significance. I still feel that very few of the general public knew what it was all about.

Dallas, Texas — PAUL BASKIN

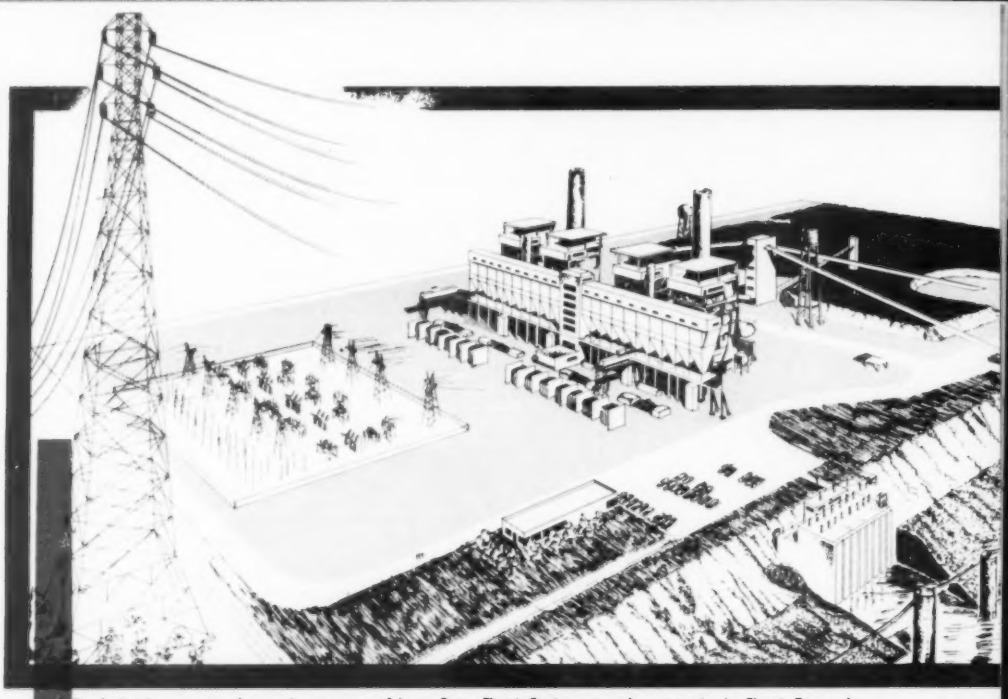


Fig. 1. Artist's conception of general appearance of Joppa Steam-Electric Station, now under construction by Electric Energy, Inc., to supply half of power for AEC's Paducah Area Project. It is of outdoor design, with 650,000 kw in four boiler and turbine units

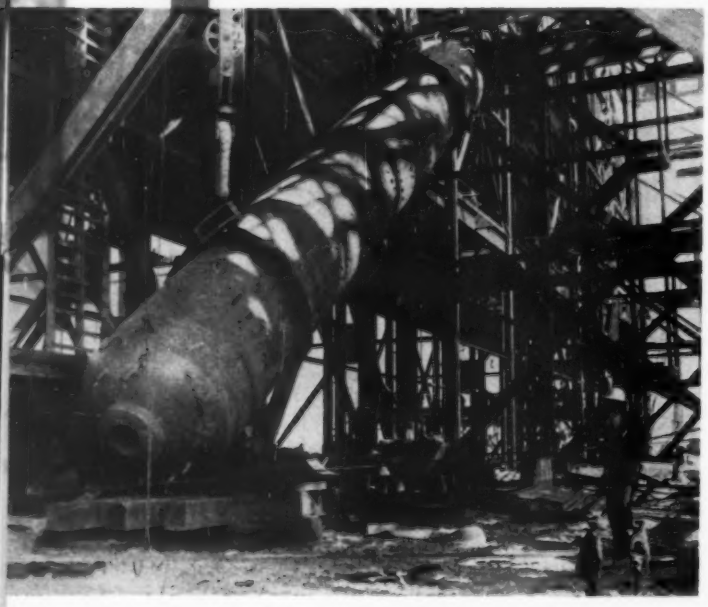


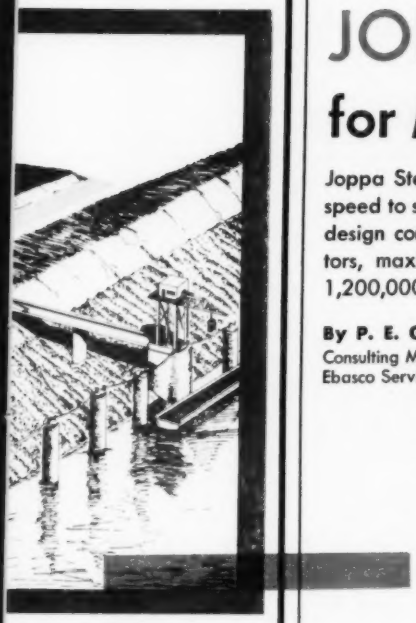
Fig. 2. Erection photograph showing one of the boiler drums at Joppa being raised into position. Drum is 50 ft long, 70 in. in diameter; one of its sections rolled from steel plate 6½ in. thick. Drum weighs 240,000 lb. In order to clear structural steel and prevent damage, the drum is raised at an acute angle

ONE OF THE largest electric power station jobs ever undertaken in one construction operation in the United States is now being rushed to completion in southern Illinois. That plant, known as Joppa Steam-Electric Station, is designed to have maximum net capability of about 650,000 kw, with four units each giving 163 mw net output. It will supply about one-half of the power required by the new uranium-refining plant now under construction for Atomic Energy Commission, located at the site of the old Kentucky Ordnance Works 16 miles west of Paducah, Kentucky. That plant, known as Paducah Area Project, is estimated to require 1,000,000 kw for its operation, making it the largest electrical consumer in the world.

Top-Speed Program

The program of planning, engineering and constructing the Joppa Power Station has been carried on at top speed, in keeping with the rapid schedule for the AEC plant. The first meeting and discussions were held in late October 1950. In December 1950, the Atomic Energy Commission approved a plan proposed by five private utility systems, for the construction of Joppa station and the supply of half the power requirements of the Paducah Area Project. The other half will be supplied from a new steam plant* under construction by Tennessee Valley Authority on the Kentucky side of the Ohio.

* Shawnee — TVA to AEC, by H. J. Petersen; POWER ENGINEERING, September 1952.



JOPPA—Big Plant, Fast, for More AEC Power

Joppa Steam Electric Station of Electric Energy, Inc. under construction at top speed to supply half of power for AEC's Paducah Area Project. Plant of outdoor design consists of four 163-mw tandem-compound 3600-rpm turbine generators, maximum total capability 650,000 kw, supplied with steam by four 1,200,000-lb-per-hr, 1925-psig, 1050-F/1005-F reheat steam generators

By P. E. GOURDON
Consulting Mechanical Engineer
Ebasco Services, Inc.

A new corporation called Electric Energy, Inc. was formed by Union Electric Co. of Missouri, Central Illinois Public Service Co., Illinois Power Co., Kentucky Utilities Co., and Middle South Utilities, Inc., to own and operate the Joppa power plant. These participating utility companies agree to supply interim power to the Paducah Area Project from their existing systems, so that process operation can be started without awaiting completion of the power stations.

Ebasco Services Inc. is retained by Electric Energy, Inc. to provide engineering, design, construction, purchasing, inspection and expediting services. Construction work was started February 15, 1951, less than three months after approval of project. Close co-ordination between the companies participating in Electric Energy, Inc. and Ebasco was necessary to permit choosing a site, placing orders for equipment, and carrying plant design forward, so as to make possible that early start of construction work.

Selection of Site

On January 16, 1951, a plant site was selected, approximately one mile square, on the right of Illinois bank of the Ohio River about 17 miles west of Paducah, Kentucky, two miles west of Joppa, Illinois, and approximately northwest and across the river from the AEC Paducah Area Project. The tract is quite flat and relatively high with respect to the river, is near the AEC plant, and is convenient for connection to the systems of participating utility companies. Ample supplies of condensing water, and of low-cost coal from fields nearby, are available, these being important considerations in selection of site.

The plant will be served by several carriers. Coal can be brought by rail from Southern Illinois and Western Kentucky coal fields, and may also be barged to the site from the Western Kentucky, Indiana, Ohio and West Virginia coal fields.

First step in construction was to build access roads and lay out railroad sidings, and to provide construction facilities including an 80-cu-yd-per-hr concrete mixing plant. The Ohio River at this point has a normal pool level of 290 ft, referred to mean sea level; an extreme low level of 275 may occur, infrequently, when navigation-dam wickets are down. Maximum flood level of record is 343 ft, and a good part of the area occupied by the plant is above that elevation.

Construction Features

It was desired to place the condensers low enough so that full siphon action in circulating-water discharge can be maintained at all normal river levels. This required excavating to a depth of about 70 ft for the condenser pit. In order to accommodate the four units, an excavation 245 ft wide and 900 ft long was needed, involving the moving of about 350,000 cu yd of dirt. Excavation was begun February 23, 1951 and work progressed rapidly, in spite of unusually rainy weather, until at about 50-ft depth much ground water was encountered. Eventually it was necessary to install over 1500 well points, so that excavation could be continued.

Foundation conditions at the site are good, so that piling is required only under points of heavy load concentration or where soil has been disturbed by condenser-pit excavation. Turbine pedestals are integral with condenser-pit walls. A 6-ft-thick concrete foundation mat supports condenser and turbine load. Finished floor, laid on a fill, is 1.5 ft above top of mat. Condenser pit and adjacent auxiliary bay accommodate condensing equipment, boiler feed pumps, low-pressure feed-water heaters, exciters, auxiliary switchgear, and other plant auxiliaries that are normally placed indoors. Roof of condenser pit and auxiliary bay forms a deck on which are located the four turbine generators, high-pressure feed-water heaters, two traveling gantry cranes, and the air-conditioned control room.

The main station structure is located about 500 ft north from the river bank. Two intake conduits of 84-in.-diameter precast concrete pipe are used, to carry circulating water from the circulating-water pumps, which are located at the intake structure at river's edge. Pump motors are not housed. Similar conduits are used to carry the discharge water to a point on the river about 500 ft downstream from intake structure. Operating machinery for the traveling intake screens is enclosed by a low housing, over which runs a 19-ton revolving boom-type traveling crane, for raising either of the eight vertical mixed-flow motor-driven circulating-water pumps. A motor-operated trash rake is provided for cleaning the trash racks.

With the construction of four units proceeding almost simultaneously, an area of about 35 acres is required for construction buildings and material storage. Constant study and detailed scheduling are required to make sure that each phase of construction shall be completed in its proper sequence and with minimum interference between various phases. For instance, backfilling of condenser-pit and auxiliary-bay excavations had to be done promptly, so that erection of bunker and boiler steel could start on schedule.

With condenser-pit and auxiliary-bay construction largely completed and boiler and bunker steelwork up, installation of equipment for the first two units can proceed rapidly, while earlier stages of construction

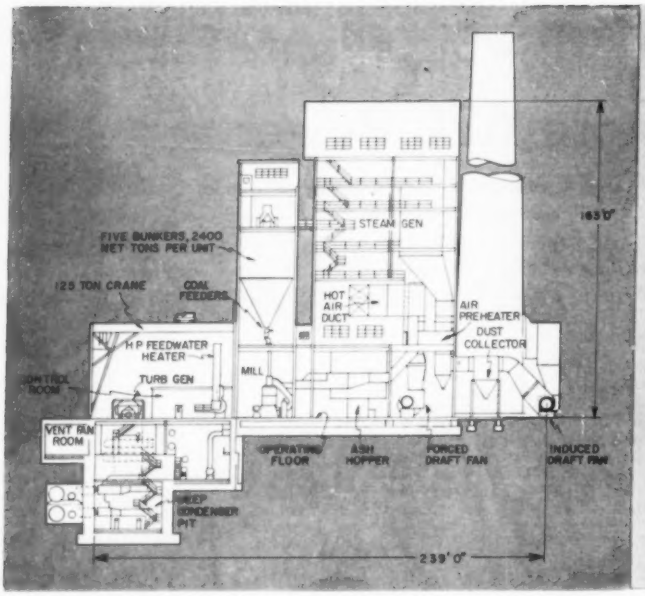


Fig. 3. General cross-section through Joppa Steam Electric Station, showing outdoor design of station. Turbine generators are on open deck, with two gantry cranes running over them as shown in Fig. 1

are carried along for units 3 and 4.

Outdoor design is chosen for the Joppa plant, to reduce construction time and investment cost, and to conserve critical materials. The four units, including equipment and arrangement, are identical. There are no cross connections except for necessary auxiliary electric connections and general facilities such as service water and compressed air. This arrangement results in simplification and in reduction in cost and time required for engineering and construction.

Plant Design and Equipment

The plant is conveniently arranged. Turbine generators, gantry cranes, high-pressure feedwater heaters, pulverizers, steam generators, forced- and induced-draft fans and dust separators, and switchyard, transformers, and oil circuit breakers, are all located at ground level and are completely in the open. Enclosures are provided around the boilers at drum and burner level; bunker tops and coal conveyors are enclosed. The space between coal bunkers for units No. 2 and 3, directly behind the control room, is enclosed to the height of the bunker tops, to house laboratories, offices, assembly rooms and locker space. Machine shop and the soot-blowing air compressors are located in a one-story building between boilers No. 2 and 3. Plant administration office is housed in a separate one-story air-conditioned building. Separate low buildings for miscellaneous stores and for repair of trucks, locomotives and bulldozers are also provided.

The turbines are three-cylinder, tandem-compound, tripleflow, 21-stage, impulse-type reheat machines, designed for steam at 1800 psig, 1050/1000 F, and for normal six-stage bleed and 1.5-in. mercury absolute back pressure. The 3600-rpm, 0.8-short-circuit-ration generators are wound for 20 kv, and are rated 150,000-kw at 0.85 power factor, giving 176,470 kva with 0.5-psig hydrogen and 216,178 kva with hydrogen pressure increased to 30 psig. Each unit is expected to give a net plant output of 163 mw (163,000 kw). Each generator is served by a 500-kw, 375-v separate motor-driven exciter, equipped with special built-in flywheel and shaft-end amplidyne pilot exciter. One spare motor-driven exciter is provided.

Condensers serving the turbines each have 90,000 sq ft of surface area, and are of the two-pass, divided-water-box type, with provision for reversal of circulating-water flow while under load, in order to remove trash from tube sheets.

Condenser deaeration of feedwater is used, eliminating the high structure required for a separate deaerator. All extraction feedwater heaters are of the closed U-type; two of the low-pressure heaters are located in the long condenser neckpiece between turbine exhaust and condenser shell. The two high-pressure heaters are vertical-type, head-downward units, while the other heaters and the evaporator-vapor condenser and turbine-gland leak-off condenser are horizontal units. A special circuit is arranged so that heat from oil coolers and hydrogen coolers may be absorbed in the feedwater, when condensate temperature is low enough for satisfactory cooling.

Three condensate pumps and three boiler-feed pumps are used with each generating unit, with two pumps designed to carry maximum turbine load. All pumps are motor driven. One 30,000-lb-per-hr horizontal U-tube evaporator, with deaerating-type preheater, is provided for each unit. Make-up to evaporator is zeolite-softened water.

There are four outdoor-type, single-drum, radiant-boiler, integral-furnace steam-generating units, one for each turbine generator. Each is designed to deliver continuously 1,200,000 lb of steam per hour at 1925 psig, 1055 F, with reheat to 1005 F, when fired with coal of 10,000 Btu per lb heat content, 15 per cent moisture and 15 per cent ash. Five Raymond bowl-type pulverizers serve each unit; four of these are rated to supply full requirements of boiler.

Each steam-generator is equipped with Elesco superheater, reheater, economizer, tilting burners, two forced-draft and two induced-draft motor-driven fans, one Ljungstrom regenerative-type air heater and one mechanical dust separator. Two 250-ft radial-brick-lined reinforced-concrete chimneys serve the four steam generating units. Compressed air is used for soot blowing, with automatic sequential-type operating control. Complete automatic combustion control is provided for the units.

Coal may be received by barge or railroad, and unloaded at the rate of about 800 tons per hour. Storage area for about 1,000,000 tons of coal is provided. Ash from the steam generators will be sluiced hydraulically to disposal areas northeast of the plant.

Electric Connections

Each generating unit is connected to the 161-kv switchyard through a bank of three 56,000/70,000-kva single-phase OA/FA transformers; one spare transformer is provided for the four transformer banks. A three-phase 15,000/18,750-kva OA/FA transformer connected to the main leads of each generator furnishes power at 4360v for unit auxiliaries. A spare auxiliary transformer of the same rating, which may be fed from Central Illinois Public Service Co. lines, is used for plant start-up and as standby for the unit auxiliary transformers.

The 161-kv switchyard is located west of the station, on the windward side of plant and coal storage area, in order to minimize deposits on insulators. The switchyard consists of a modified ring bus with a total of nine 161-kv oil circuit breakers, with connections to the four generators, the four transmission lines leading to the Atomic Energy Commission's substations, and to the Central Illinois Public Service Co. 161/230-69-kv substation. The 161-kv oil circuit breakers are rated at 10,000,000-kva interrupting capacity. The four 161-kv transmission circuits that span the Ohio River are carried on two sets of double-circuit steel crossing towers. From this point, four separate single-circuit lines carry the power to the AEC substations.

Control and Communication

One tunnel-type control board of compact design serves each boiler-turbine-generator unit. All four boards are located in the central control room, for maximum convenience and most effective control. Miniature indicating instruments are arranged in schematic outline diagram on the face of the control board, in such manner that power production-processes from fuel to generator outlet can be readily followed. Major piping and electrical circuits are shown in distinctive colors, to aid in identification of the respective functions. Practically all units of equipment are controlled from this board.

A separate dispatching office adjacent to the Joppa plant will include space and control facilities for dispatching the power supply to the AEC load, and for control of power interchange on the tie lines to participating companies Automatic loading of Joppa generators is provided.

Telephone, microwave and carrier-current communication facilities will be provided, connecting Joppa to the Paducah Area Project, the Shawnee plant of TVA, Kentucky Utilities, and other utilities north of Joppa. Radio communication will provide for emergencies.

Power in excess of that needed by the AEC plant will be available to the five participating utilities over the interconnected systems. A new 230,000-v transmission line is under construction, connecting the Joppa plant to Union Electric's Cahokia station, across the Mississippi from St. Louis, with an intermediate substation where connections are made to the systems of Illinois Power Co. and Central Illinois Public Service Co. This line will provide adequate transmission capacity, and will permit supplying power to the AEC plant for preliminary operations before Joppa is completed. It will also provide reserve capacity.

Principal Equipment, Joppa Steam-Electric Station
Electric Energy, Inc., Joppa, Illinois

TURBINE GENERATOR EQUIPMENT

Turbine Generators—Four 125,000/156,250-kw (each) turbine generators, 1800-psig 1050/100-F, 3600-rpm, three-cylinder tandem-compound, triple-flow, 21-stage impulse-type, six-stage bleed, 60-cycle, 3600-rpm, 20,000-v, 0.8-scr, hydrogen-cooled, 150,000-kw at 0.85-power factor, 176,470-kva at 0.5-psig, 216,178-kva at 30-psig. General Electric Co.

Exciters—Five 500-kw main exciters, 375-v 900-rpm, air-cooled, direct driven by 750-hp, 4160-v, 3-phase, 60-cycle motors. General Electric Co.

Condensers—Four 90,000-sq ft, 816,000,000-Btu-per-hr duty, horizontal, two-pass, vertical-divided-water-box, deaerating-type, surface condensers, each with two IR vertical mixed-flow, single-stage 94-cfs, 45-ft tdh, 600-rpm, motor-driven circulating-water pumps; three IR vertical-reentry valuta five-stage 700,000-lb-per-hr 858-ft tdh condensate pumps; one IR two-stage twin-element steam-jet air ejector, with surface-type inter- and after-condensers and two priming ejectors per unit. Ingersoll-Rand Co.

Boiler Feed Pumps—12 Nine-stage, single-suction, barrel-type, 3575-rpm, 700,000-lb-per-hr, 5550-ft tdh, 360-F water, direct-drive, motor-driven boiler feed pumps. Allis-Chalmers Manufacturing Co.

Pumps—27 Miscellaneous pumps for general service, condensate cooling water, evaporator, heater drain, ash nozzle and lube oil transfer duty. Worthington Corp.

Feedwater Heaters—4 sets of feedwater heaters consisting of: one cross-over and one 10th-stage high-pressure heater, U-tube, two-pass, vertical, head-down, feedwater heaters with desuperheating, condensing and after-cooling sections, designed for 3200-psig, 500-F water; one gland-steam condenser; one 13-stage heater; one evaporator-vapor condenser, horizontal two-pass, U-tube type, designed for 450-psig water pressure; one 15th-stage, one 17th-stage, and one 19th-stage feedwater heater, horizontal, four-pass, U-tube type, designed for 450-psig water pressure; one 30,000-lb-per-hr evaporator, horizontal U-tube, 150-psig design, with deaerating preheater; one cooling-water heat exchanger; designed to heat condensate and boiler feed to 470-F final temperature, and supply up to 3 per cent evaporated make-up water. Foster Wheeler Corp.

STEAM GENERATOR EQUIPMENT

Steam Generators—Four outdoor-type, single-drum, radiant-boiler, integral-furnace, steam generators, 1,200,000-lb-per-hr each steam at 1925 psig, 1055 F, with reheat to 1005 F, pulverized-coal-fired with provision for fuel oil and natural-gas use; Elesco superheater, economizer, reheater, 20% tilting burners; two Ljungstrom 110,200-sq ft air-heaters, two American Blower-type 763 ANS 202,000-cfm, 880-rpm, damper control, motor-driven forced-draft fans; two American Blower-type 810 Sirocco 325,000-cfm, 585-rpm, louver-damper control, motor-driven induced-draft fan; five Raymond No. 673 bowl mill pulverizers; one Western Precipitator mechanical dust separator; one set Vulcan automatic sequential air soot-blowing equipment per unit. Combustion Engineering-Superheater, Inc.

Piping Systems—Complete power-plant piping systems, fabricated and erected. Grinnell Co.

Ash Removal Systems—2 Complete ash- and dust-removal systems, each designed for 36 tons per hr furnace-bottom ash and 50 tons per hr fly ash, with sluice systems for ash hoppers, clinker grinders, transport nozzles and Hydroveyor fly-ash conveyors. United Conveyor Corp.

Chimneys—2 Radial brick-lined reinforced-concrete chimneys, 250-ft high, 24-ft top internal diameter. Alphons Custodis Chimney Construction Co.

Air Compressors—4 Soot-blower air compressors, 2820-cfm, 500-psig discharge, 3-stage, double-acting, motor-driven. Ingersoll-Rand Co.

4 Instrument air compressors, 445-cfm, vertical, 4-cylinder, 2-stage, motor-driven. Chicago Pneumatic Tool Co.

Control Boards—4 Boiler-Turbine-Generator control boards, tunnel-type, miniature remote-type instrumentation. Panellit Inc.

Automatic Controls—4 Complete sets combustion-, load- and frequency-control equipment. Leeds & Northrup Co.

COAL HANDLING SYSTEM

Floating Docks—Two 20-ft x 200-ft floating coal-unloading docks and one 20-ft x 120-ft warehouse barge with motor-operated Capstan. Ingalls Shipbuilding Corp.

Unloading Tower—1 Coal-barge unloading tower, 900-ton-per-hr capacity, with barge haul equipment. McKiernan-Terry Corp.

Coal-handling System—Coal-handling system, 800-ton-per-hr capacity, including rotary railroad car dumper, car shake-out, trippers, crushers, scalping screens, 42-in. belt conveyors from car dumper, double 36-in. distribution belt to plant, storage chute, and two 400-ton-per-hr reclaimed-coal conveyors. Link-Belt Co.

Scrapers—2 Euclid twin-engine scrapers, 18-cu yd capacity. Hubbard and Floyd, Inc.

Locomotives—2 Diesel-electric locomotive, 44-ton, 400-h. p. General Electric Co.

OTHER EQUIPMENT

Cranes—2 Station traveling gantry cranes, 125-ton capacity, 75-ft span, 60-ft lift. Bedford Foundry and Machine Co.

Crane—1 Intake structure crane, 19-ton, revolving lifting boom, traveling-type, electric operated. Colby Steel and Manufacturing, Inc.

Traveling Screens—8 Vertical traveling refuse screens, 102-in. wide, 86-ft deep. Link-Belt Co.

Tanks—2 Elevated steel water-storage tanks, 135 ft high; one 50,000-gal capacity for well water, one 100,000-gal capacity for river water. Chicago Bridge and Iron Co.

Chlorination—1 Chlorination installation for intermittent de-sliming of surface condensers and for well-water purification. Wallace and Tiernan Products, Inc.

Chemical Feed—1 Chemical-feed installation for proportioning feed of sulphite and phosphate solution to individual units. Milton Roy Co.

Oil Conditioners—4 Bowser size 4 turbine oil conditioners and auxiliary equipment. Bowser, Inc.

ELECTRIC EQUIPMENT

Auxiliary Motors—73 Motor drivers for auxiliary equipment, 400- to 2500-hp, 3-phase 60-cycle, 4000-v, squirrel-cage induction-type. Elliott Co.

Auxiliary Motors—127 Motor drivers for smaller auxiliary equipment, 1- to 250-hp, 3-phase, 60-cycle, 440-v, squirrel-cage induction-type. Elliott Co.

Power Centers—14 Sets metal-clad power centers, indoor-type, each including 750-kva 4160/480-v, 3-phase, 60-cycle, dry-type transformer direct connected to 4800-v switchgear. Westinghouse Electric Corp.

Auxiliary Switchgear—10 Sets metal-clad switchgear, indoor-type, for control of 4160-v station auxiliaries. Westinghouse Electric Corp.

Auxiliary Transformers—5 Auxiliary transformers, outdoor-type, 15,000/8750-kva, 3-phase, 60-cycle, type OA/FA, low voltage 4360, higher voltage four units at 20,000 v, one unit at 167,000 with adjustable taps. Pennsylvania Transformer Co.

Main Transformers—13 Main power transformers, outdoor-type, 56,000/70,000-kva, single-phase, 60-cycle, type OA/FA, 20,000/161,000-v with voltage adjusting taps. Pennsylvania Transformer Co.

Circuit Breakers—9 Oil circuit breakers, outdoor-type, 161-kv, 1200-amp, three-pole, single-throw, 10,000,000-kva interrupting capacity, ten-cycle closing time, three-cycle interrupting time, adjustable 15- to 45-cycle automatic reclosing time. Pacific Electric Manufacturing Co.

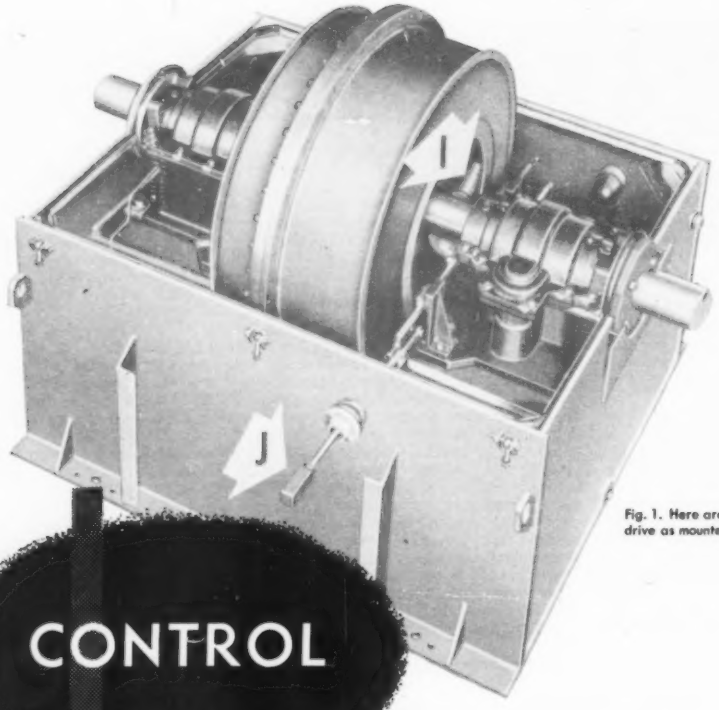


Fig. 1. Here are the complete works of the fluid drive as mounted in the casing and oil reservoir

CONTROL of Fluid-Driven Fans

By J. F. TOBIN, Manager
Industrial Sales Division
American Blower Corp., Chicago

BASIC PRINCIPLE of transmitting power through a vortex ring of oil without direct mechanical connection is so well understood by most people in this country today, because of its almost universal use on automobiles, that no space will be devoted to describing this basic principle. The automotive type fluid drive is a constant-filled device and does not in itself provide variable speed. When fluid drive is used with constant-speed electric motors to produce variable speed on a forced or induced draft fan, oil must be added to or removed from the driving oil vortex, and at the same time, this oil must be continuously cooled to remove the heat equivalent of the slip horsepower.

In the Type VS Class 4 variable-speed fluid drive, Fig. 1, the oil is contained in a tank. The tank has an oil level gage and a removable top section. This tank encloses all working parts and is the base of the machine. The oil cooler and oil filter are mounted externally as shown in Fig. 4, and the unit is connected by flexible couplings to the driving motor and to the fan. It can be set on its own base, independent of either the fan or the motor, the base being of ample area to catch any oil drip, and is provided with a bottom sloping to a tapped connection on the side, so that oil can be collected easily if any is spilled during filling of the device. During normal operation, the fluid drive is very free of oil drip and is easily kept clean.

The oil is constantly circulated by a centrifugal pump A, Fig. 5, gear-driven from the input shaft, through the externally-mounted oil cooler B, Fig. 4, next through both radial bearings C, Fig. 1, then through the Kingsbury thrust shoes D, and out into the driving oil vortex between impeller E, and runner F, Figs. 3 and 5. Large ports are provided in the inner casing G, Fig. 5, to permit oil to assume a level, in a space between it and the outer casing H, proportionate to the amount of oil in the driving vortex.

The large-capacity scoop tube slides in and out in horizontal fixed guides, similar to the cross-feed carriage on a lathe, to peel off the revolving ring of oil and return it to the reservoir in the base. This scoop tube is directly operated by a rod J, Fig. 1, extending through the side of the fluid drive for easy connection to automatic control stand. The scoop tube handles the same quantity of oil as the pump capacity when in a fixed position for constant output speed.

On reducing speed, the scoop tube is jammed deep into the revolving oil ring, handling, during this period, more oil than is supplied by the pump. When operating at full out-

Vortex ring of oil transmits power without mechanical connection in the well-known fluid drive. It is now used on power plant forced- and induced-draft fans. Control of speed is accomplished by pushing a lever in and out of the drive. Here are details of how the drive works

put speed, it is possible to empty the driving vortex in 4 to 5 sec. A force of 70 to 110 lb. is required to move the control rod a distance of 5 in. to 14 in., depending on the size of the unit, to empty the driving vortex at this maximum rate.

On increasing speed, the scoop tube is drawn away from the revolving oil ring. Very little force is required for this movement. The oil pump fills the circuit up to the new scoop tube position, at which point it returns the pump capacity of oil to the tank and a new oil level is established for the new speed.

Capacity of the oil pump establishes the rate of filling the driving vortex. For fan work, a pump of sufficient size to fill it completely in 25 to 45 sec. is most desirable. This selection depends upon the size and speed of the fluid drive. Time for partial filling is proportional to normal boiler swings and usually is accomplished in a very few seconds.

On acceleration of the fan, the driving motor is capable of constantly applying in excess of full-load torque through the fluid drive to the fan, to overcome the inertia of the wheel, which is a constant, and the air resistance of the wheel, which increases as the square of the speed. On deceleration, the constant wheel inertia tends to keep the fan wheel turning and the variable air resistant torque retards or brakes the wheel at a variable rate. The composite picture is that it is necessary to remove oil at a much faster rate than it has to be supplied if the overall response characteristics up and down are to be similar, which is the preferred situation for best automatic control.

There are no inertia delays in the VS-Class 4 as the oil is always flowing at full capacity. It is possible to position the scoop tube to overfill momentarily, to use full motor torque for slight speed changes and then rapidly remove the surplus oil on reaching the desired speed. On quick drop in speed, all the oil can be removed from the driving vortex in a few seconds, letting the speed fall freely until the desired speed is approached, when the scoop tube will be withdrawn to the correct position, letting the oil pump fill the driving vortex to the point at which the new speed will be established.

A typical performance curve of a properly-selected fluid drive is shown in Fig. 6. It illustrates the torque capability of the unit at various scoop tube positions. The torque requirements, square curve, of a fan load are superimposed to illustrate the sharp intersections at all useable loads. This means ability to control without hunting at any control rod setting.

The VS-Class 4 is designed to eliminate anti-friction, ball, or roller bearings and all electrical connections. It is designed for fast, simple, accurate speed control and is the result of the extensive use of variable-speed fluid drive over 20 years.

Fig. 2. Regulator operates horizontal scoop tube lever of fluid drive on large induced draft fan in midwestern central station

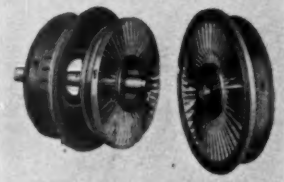


Fig. 3. Heart of fluid drive: Outer casing H; Runner F; Impeller E, as explained in text

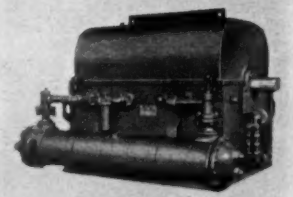


Fig. 4. Complete fluid drive installed, with oil cooler B mounted on outside of reservoir

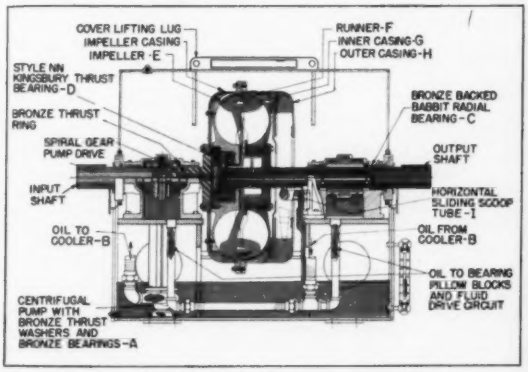


Fig. 5. Cross-section through fluid drive showing how input and output assemblies connect only through oil circuit, controlled by scoop tube position

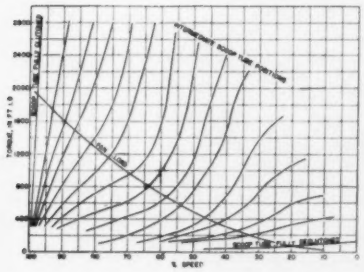
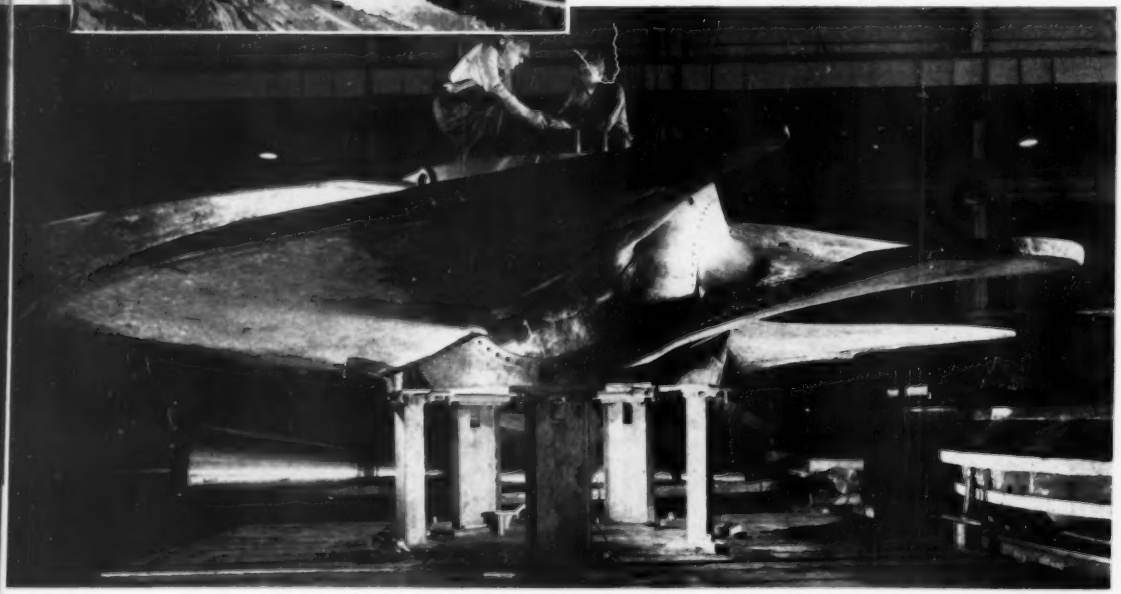


Fig. 6. Typical performance curve of fluid drive showing torque capability at various scoop tube positions

Above—Assembling the first of two water-wheel generators at Hungry Horse Dam. This rotor weighs 1,000,000 lb. Generator is rated 71,250 kw

Left—When Hungry Horse is completed it will store 3,500,000 acre-feet of water and add 800,000 kw of power to the Northwest Power Pool

Kaplan propeller-type water wheel runner for 55,000-hp, 48-ft head, 81.8-rpm Allis-Chalmers hydraulic turbine at TVA Pickwick Landing Plant

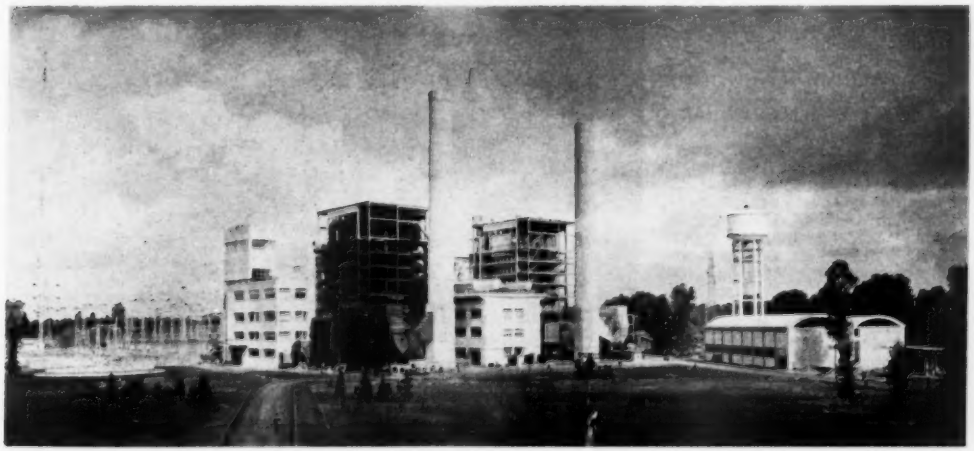


Roman Senator, modern miss at Centennial of Engineering

Power Engineering NEWS REEL

Above—401,000-lb stator of 175,000-kw generator for East River Station of Consolidated Edison, N. Y., built by General Electric Co.

Tavazzano Power Station, Milan, Italy. First Italian steam power station to use natural gas fuel. The station output is 125,000 kw



WHAT SIZE

By **W. R. HARRIS**, Manager
Steel Mill Engineering,
Westinghouse Electric Corp.

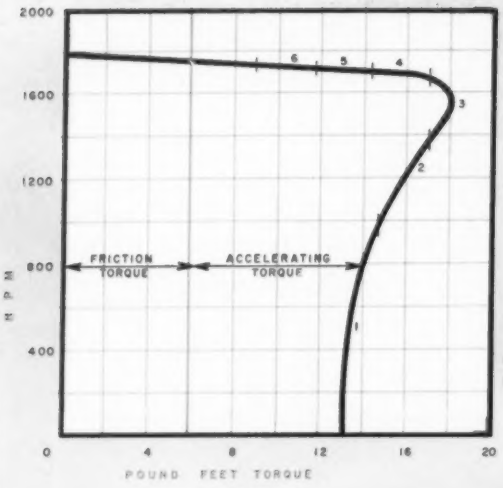


Fig. 1. Speed-torque curve of squirrel-cage induction motor; non-uniform accelerating torques

SUCCESSFUL application of electric motors to industrial machinery requires much more than a knowledge of motor design and operating characteristics. Most important phase of the additional information required is a thorough knowledge of fundamental mechanics. Such knowledge is useful in caculating power requirements of various machines, interpreting power data, selecting flywheel characteristics, plotting duty cycles, and determining acceleration and retardation time, force, and energy relationships.

In the analysis of drive systems, the power engineer or the electrical application engineer probably spends more time with fundamental mechanics than he does with electrical phenomena. It is just as important to find out accurately what the motor or drive system has to do, as it is to design a motor or drive system to perform specified functions. For instance, on four- and five-stand tandem mills for cold reducing steel strip, it is necessary to bring the machine as a whole up to speed while maintaining proper speed and tension relationships between the individually-driven stands and the reel drives. Tension between stands is a considerable portion of the total motor load, and the accelerating forces can equal or exceed the rolling load. For instance, the fifth-stand motor of a mill for rolling tinplate is rated 3500 hp and has the following loads:—

Rolling hp	2700
Back Tension hp	1000
Forward Tension hp	400
Net hp running	3300
Accelerating hp	2400
Net hp accelerating	5700

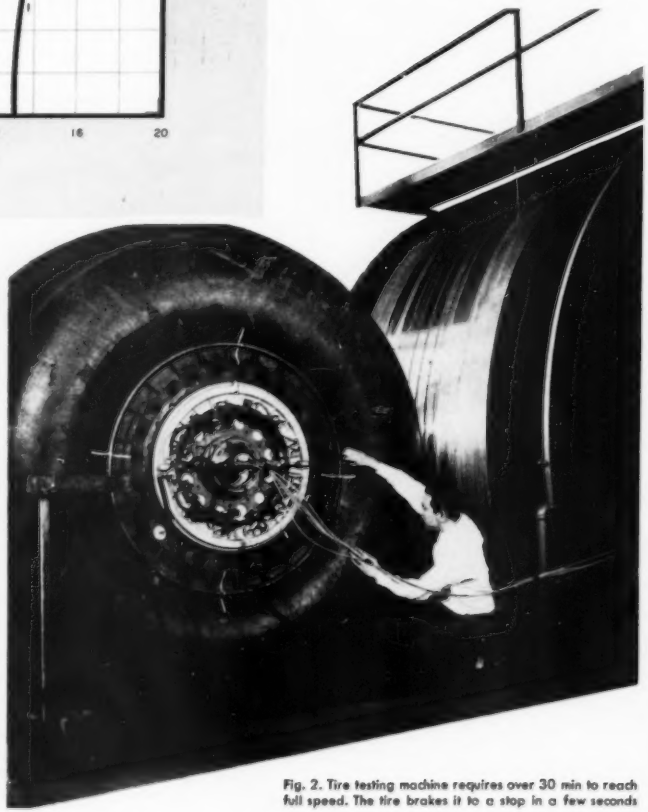


Fig. 2. Tire testing machine requires over 30 min to reach full speed. The tire brakes it to a stop in a few seconds

Under emergency conditions such a mill can be stopped from 4000 fpm in 3 to 4 sec while maintaining tension between all stands and can then be started up again without breaking the metal. Such performance is due to accurate determination of the operating requirements through the use of fundamental mechanics and to designing the drive motors and associated control systems to meet these conditions.

Any good textbook on mechanics contains the fundamental formulae needed for application work. However, these data are seldom worded in engineering terms and units and are not available in readily usable form. This article describes and develops that part of fundamental mechanics most useful to power and electrical application engineers. Most of the

DRIVING MOTOR?

To get correct driving motor for a given job, power engineer must start with driven machine's needs. Starting there, here's how he can figure back to driving motor horsepower, speed, acceleration time, and duty cycles. . . .

data are given or can be derived from a few fundamental formulas as follows: —

Rotation	*Translation*
$T_x = I\alpha$	$F_x = Ma$
$E_w = T\theta$	$E_w = FS$
$P = T\omega$	$P = F \times V$
$E_k = \frac{I\omega^2}{2}$	$E_k = \frac{MV^2}{2}$
$I = \frac{Wk^2}{g}$	$M = \frac{W}{g}$

In these formulas, the terms are:

- T = torque in pounds feet
- T_x = accelerating torque
- I = inertia in pound feet seconds squared, which is the product of weight by radius of gyration squared, divided by the acceleration of gravity.
- g = acceleration of gravity = 32.2 ft per sec per sec, approx.
- α = angular acceleration in radians per second per second
- W = weight in pounds
- k = radius of gyration in feet
- E_w = work done in pound feet
- P = power or rate of doing work in pound feet per second
- θ = angle in radians (2π radians in one revolution)
- E_k = Kinetic energy in pound feet
- ω = angular velocity in radians per second
- F = force in pounds
- F_x = accelerating force
- a = acceleration in feet per second per second
- M = mass in pound seconds squared per foot or $\frac{W}{g}$
- S = distance in feet
- V = velocity in feet per second

Rotation — Hp — Torque — Rpm: — Horsepower is the rate of doing work and is defined as 550 ft lb per sec or 33,000 ft lb per min.

$$Hp = \frac{T\omega}{550}$$

$$\omega = \frac{rpm}{60} \times 2\pi$$

$$Hp = \frac{T \times rpm \times 2\pi}{550 \times 60} = \frac{T \times rpm}{5250}$$

Usually the hp and rpm of a motor are given on the nameplate and it is necessary to know the starting torque.

$$T = \frac{HP \times 5250}{rpm}$$

A useful rule of thumb is that one hp at 1750 rpm is equivalent to 3 lb ft torque. By rationing hp and rpm, the torque of any motor can be estimated mentally.

Translation — Hp — Force — Velocity: —

$$Hp = \frac{F \times V}{550} \text{ or } \frac{F \times fpm}{33{,}000}$$

This relationship is useful in many instances. For example, a strip of steel between two stands of a tandem cold reduction mill is running at 3300 fpm and has a total tension of 10,000 lb. The hp developed is: —

$$Hp = \frac{F \times fpm}{33{,}000} = \frac{10{,}000 \times 3300}{33{,}000} = 1000$$

Rotation — Time to Accelerate: — One of the most frequent problems is to figure the time required to accelerate a motor and the machine it drives. A simple formula can be derived from the fundamental relation: —

$$T_x = I\alpha = I\frac{d\omega}{dt}$$

Since: —

$$\omega = 2\pi \times \frac{rpm}{60}$$

$$I = \frac{Wk^2}{g}$$

$$t \text{ (secs)} = \frac{Wk^2 \times (rpm_2 - rpm_1)}{308 \times T_x}$$

This formula can also be easily derived without the use of higher mathematics as follows, assuming again that torque is constant during the accelerating period.

(a) $T_x = I\alpha$

(b) $\omega_2 - \omega_1 = \alpha t$, which means that the difference in speed is equal to the product of acceleration and time.

By solving for acceleration in (b) and substituting the value in (a) we get: —

$$T_x t = I(\omega_2 - \omega_1)$$

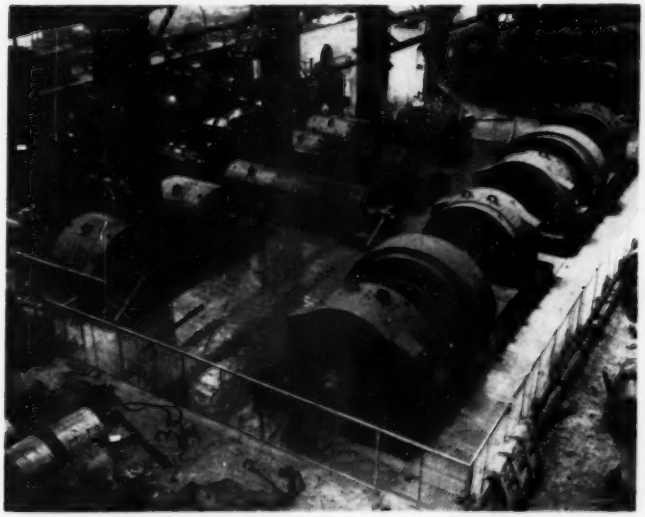
which is identical to the formula obtained mathematically.

For example the tire tester shown in Fig. 2 consists of a huge flywheel, brought up to speed by a motor and stopped by pressing the tire against it and applying the brakes. The flywheel and motor have a Wk^2 of 10,000,000 lb ft^2. The motor is rated 400 hp at 350 rpm, 6000 lb ft rated torque. The variable voltage control system is designed to apply full load torque continuously during the accelerating cycle. The time to accelerate is: —

$$t = \frac{10{,}000{,}000 \times 350}{308 \times 6000} = 1890 \text{ sec} = 31.5 \text{ min}$$

Limitations of this formula should be carefully noted. Constant accelerating torque was assumed in deriving the formula and if the accelerating torque is not uniform —

Fig. 3. View of 5-stand tandem cold reduction mill driven by a total of 17,550 hp in d-c motors. Good performance is obtained under accelerating conditions through the use of fundamental mechanics



which is usually the case — an error is introduced. The error is small for small torque variations, and by breaking up the speed-torque curve into segments and calculating the time for each segment the total time can be calculated very accurately.

Friction, windage, and load reaction torques must be subtracted from the motor torque in order to obtain the torque available for acceleration. As an example, consider the speed torque curve of a squirrel cage motor as shown in Fig. 1. Assume a Wk^2 of 10 lb ft² and a constant friction or load torque of 6 lb ft. It would theoretically take an infinitely long time to accelerate to the point where the friction torque equals the motor torque as the accelerating torques become progressively smaller. So calculate the time required to accelerate to 1750 rpm as follows:

Table showing calculation of acceleration torque involving speed, average motor torque and load torque

Step	RPM	Difference RPM	Average Motor Torque	Load Torque	Average Acc. Torque	Seconds Acc. Time
1	0/1000	1000	13.5	6.0	7.5	4.33
2	1000/1400	400	15.5	6.0	9.5	1.37
3	1400/1670	270	17.5	6.0	11.5	0.76
4	1670/1715	45	15.7	6.0	9.7	0.15
5	1715/1730	15	13.1	6.0	7.1	0.07
6	1730/1750	20	10.4	6.0	4.4	0.15
					Total Time	6.83

Translation — Time to Accelerate: — By starting with the relation $F_x = Ma$ and proceeding as shown under Rotation — Time to Accelerate the formula for translation accelerating time is derived as: —

$$t = \frac{W(fpm_2 - fpm_1)}{1932F_x}$$

The same general limitations as discussed under Rotation — Time to Accelerate apply here. Where the force is not constant a similar procedure should be used to obtain an accurate estimate of time.

For example assume a planer bed and load which weighs 40,000 lb and which is to be accelerated to 200 fpm in the return stroke. The force is 3600 lb. The time of acceleration is:

$$t = \frac{40{,}000 \times (200 - 0)}{1932 \times 3600} = 1.15 \text{ sec}$$

Shafts at Different Speeds: — Motors are often geared or belted to the machines they drive and different parts of machines may run at widely different speeds. To facilitate calculations it is desirable to get the equivalent Wk^2 of the complete system at one point — usually at the motor shaft. To transfer Wk^2 remember that the stored energy of the system remains the same. Thus: —

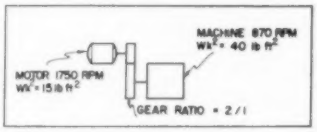
$$\frac{I_1\omega_1^2}{2} = \frac{I_2\omega_2^2}{2}$$

$$I_1 = I_2\left(\frac{\omega_2}{\omega_1}\right)^2$$

or in other terms: —

$$(Wk^2)_1 = (Wk^2)_2 \times \left(\frac{rpm_2}{rpm_1}\right)^2$$

For example, consider the following system and obtain the total Wk^2 at the motor shaft.



Wk^2 of machine at motor

$$= 40 \times \left(\frac{875}{1750}\right)^2 = 10 \text{ lb ft}^2$$

Wk^2 of motor at motor = 15 lb ft²

Total Wk^2 = 25 lb ft²

Straight Line Motion: — Bodies such as planer beds, elevators, log carriages, and cranes and hoists have straight line motion. They are connected to the driving motors by either rack and pinion or cable attached to drums. Such drives may be required to meet rigid duty cycles and often require careful evaluation of accelerating and decelerating torques and times.

To obtain an equivalent Wk^2 at the motor shaft equate the stored energies and solve for the Wk^2 as follows:

$$\tfrac{1}{2}g\,I\omega^2 = \tfrac{1}{2}g\,MV^2$$

Reduce to engineering terms and cancel out $\tfrac{1}{2}g$.

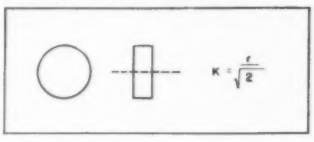
$$\frac{Wk^2}{g}\left(\frac{rpm \times 2\pi}{60}\right)^2 = \frac{W}{g}\left(\frac{fpm}{60}\right)^2$$

$$Wk^2 = W\left(\frac{fpm}{rpm \times 2\pi}\right)^2$$

For example, assume a motor geared to a planer bed so that 600 rpm of the motor is equivalent to 628 fpm of the planer bed. The bed and work weighs 1080 lb. The equivalent Wk^2 of the planer bed at the motor shaft is:

$$Wk^2 = 1080\left(\frac{628}{600 \times 2\pi}\right)^2 = 30 \text{ lb ft}^2$$

Radius of Gyration: — The radius of gyration of a circular disk or cylinder about the center is:



Radius of gyration of a hollow circular disk or cylinder about the center is:

These two shapes are the ones mostly found in engineering practice. For the radius of gyration of other shapes refer to handbooks or calculate.

HP Seconds Stored Energy: — In work with flywheels such as those for punch presses, shears, wood chipper discs, and flywheel m-g sets used in metal rolling and mine hoist applications, it is convenient to know the stored energy in terms of hp-seconds. Since the change in kinetic energy is equal to the work done, the hp-seconds for a system in rotation are:

$$\text{Hp-sec.} = \left(\frac{1}{2}\frac{I\omega_1^2}{550}\right) - \left(\frac{1}{2}\frac{I\omega_2^2}{550}\right)$$

$$= \frac{Wk^2 \times (Rpm_1^2 - Rpm_2^2)}{3{,}231{,}000}$$

For translation:

$$\text{HP secs.} = \left(\frac{1}{2}\frac{MV_1^2}{550}\right) - \left(\frac{1}{2}\frac{MV_2^2}{550}\right)$$

$$= \frac{W \times (Fpm_1^2 - Fpm_2^2)}{127{,}512{,}000}$$

For example, an 84-in., 10-knife, 375-rpm chipper in the paper industry has a Wk^2 of 130,000 lb ft². From available power data it is known that 1620-hp-sec is required to chip a 14-in. diameter oak log 4 ft long. The torque of the wound-rotor driving motor is small compared to the load torque and can be neglected. Calculate how much the system will slow down when chipping one log.

The stored energy in the chipper disk is $\frac{130{,}000 \times (375)^2}{3{,}231{,}000} = 5660$ hp sec. The energy remaining after the cut will be 5660–1620 = 4040 hp sec. Since the stored energy varies as the square of the speed, the per unit speed after the cut will be:

$$\sqrt{\frac{4040}{5660}} = \sqrt{0.712} = 0.845$$

Rpm = 0.845 × 375 = 317

Use of energy expressed in hp-seconds as in the above example often results in considerable simplification of calculation work. Consider for instance that logs are fed at specified intervals. It is a relatively simple matter to determine the end result through use of stored energy, whereas it would be considerably more time consuming if torque, time, and Wk^2 values were used.

The information presented in this paper covers the fundamental mechanics needed for about 99 per cent of industrial motor applications. A thorough knowledge of such data is one of the most handy tools in the power engineer's kit and proper use of it is the best assurance of successful applications.

Power Engineering's

PRACTICAL ENGINEER and ELECTRICIAN SECTION

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Babbitted Bearings—
Reasons for Troubles, and Their Cures

When using babbited bearings, failures can cause machine damage and losses in downtime. If a bearing failed and it was necessary to pour your own, could you do it? Here are some causes of failures and cures plus how to pour your own, recommended by American Smelting and Refining Co.

BABBITTED BEARINGS are used today in a wide variety of power plant equipment. Consequently, the troubles that occur in them and the ways of overcoming these troubles are part of the fundamental operating knowledge of all power engineers. It must be emphasized that the babbitted bearing, when properly used and maintained, is one of the most dependable and rugged components of modern machinery. However, here is a brief once-over of the principal precautions you must take to keep them at top performance.

1 — Trouble in the bearing metal itself:

Cause: Selection of wrong bearing metal for job.

Cure: The recommendation of the equipment supplier or a reputable manufacturer of bearing alloys should be sought and followed. Generally speaking, tin-base babbitts are best for high speeds and heavy-duty service . . . lead-base babbitts for medium or low speeds and loads.

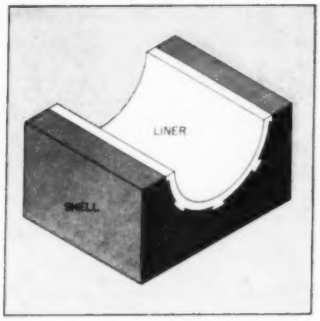
2 — Trouble in making the bearings:

Cause: a. Improper method of melting
b. Improper bond between liner and shell
c. Porosity of liner, segregation of the constituents in liner and hard spots which cause scoring of shaft.

Cure: a. Melting
1. Make sure melting pot is clean
2. Heat kettle uniformly to prevent segregation
3. Stir molten metal thoroughly using long-handled steel rod with perforated steel plate attached (Fig. 1)
4. Control metal temperature with pyrometer. If none is available use white pine shaving. When molten babbitt starts to turn the wood brown, it is ready to pour (Fig. 2)
5. Do not allow the metal to cool or stand overnight in pot. Segregation will usually occur
6. Do not add drosses, sweepings, or skimmings. They usually contain detrimental impurities. The safest and least expensive procedure is to return all these materials to a reputable smelter for refining

b. Bonding
1. Machine the shell surface to a "phonograph" finish. Avoid use of lubricant when taking last cut
2. Degrease in a commercial alkaline cleaner held just below its boiling-point
3. Etch for 3 to 5 minutes in a water solution of 50 per cent hydrochloric (muriatic) acid held at 160 to 180 F. If not clean, repeat degreasing and etching
4. Dip into a flux at 150 F. A saturated solution of two parts zinc chloride and one part of ammonium chloride in water is usually satisfactory
5. Dip the shell into a bath of molten bonding alloy (tinner's solder) kept about 150 F above its liquidus temperature. The shell should have a silvery appearance on removal from the bath. *The shell should not be allowed to cool before casting the liner*

c. Casting
1. The mandrel and shell should be at a temperature higher than 250 F to eliminate the danger of moisture or steam. The shell should be at a temperature above the melting point of the bonding or tinning metal. The temperature of the mandrel should be approximately 100 F higher than that of the shell so that solidification can progress from the shell to the mandrel
2. The stream of metal should be poured against and moved around the circumference of the mandrel to prevent local overheating
3. Use a ladle of sufficient capacity to permit pouring the entire bearing at one time; this re-



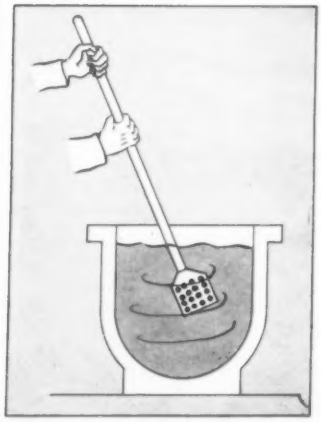


Fig. 1. Use of a stirring rod with perforated plate

Fig. 2. How to test temperature with pine shaving

duces the likelihood of cold spots, laminations, folds, or hard spots

3 — Trouble in installation of bearings:

Cause: a. Presence of foreign particles (dirt or metal chips)
b. Insufficient or excessive clearance
c. Misalignment of shaft

Cure: a. Make certain all foreign particles, such as dirt, metal chips and lint, are wiped from the bearing and shaft with a lint-free material
b. Make certain the clearances between the bearing and the shaft are adjusted in accordance with manufacturer's recommendations
c. Make certain shaft and bearing are in proper alignment and the tension of the bolts is even.

4 — Trouble in operation and maintenance of bearings:

Cause: a. Use of improper lubricants
b. Failure to filter foreign particles from lubricants
c. Overloading or overspeeding of equipment
d. Corrosion due to overheating of lubricant
e. Corrosion due to dilution of lubricant with acidic compounds or water
f. Fatigue caused by high local compressive and high local bending stresses

Cure: a. Select the proper lubricant. In most cases the equipment manufacturer has recommended the lubricant found to have the necessary properties
b. Set up a regular maintenance and inspection schedule for all bearings and *follow it closely*
c. Keep lubricants free of all foreign matter (you bought it that way) by using proper filtering and cleaning devices
d. Run the equipment at the speed and under the load for which it was designed

"Running pretty hot, isn't it?"

Handy Labeling Tape

WHAT'S the number of this circuit? Its voltage? Is it ac or dc? How many amps? What phase? Where is the panel that it serves? Which fuse has blown?

An immediate and correct answer to one or all of these questions is frequently needed to prevent loss of time, damage to equipment or even personal injuries. While many systems have been devised to provide such answers, one of the simplest is through use of the recently developed type of plastic marking tape shown here — a new marking tape on which all necessary circuit data can be noted and the tape applied directly to panels, circuit breakers, switches, fuses, wall outlets and as *flags* to wires and drop cords. The tape is pressure sensitive, made to stick without moistening to any dry and comparatively smooth surface.

The new tape may be written on with a pencil or any pointed instrument — but the writing is not on the surface of the tape. It appears beneath a transparent plastic outer layer which protects it against smudging, dust, dirt, oil, water and chemicals.

Temperatures between −40 F and 160 F do not affect the tape in any way, it is claimed. It is designed to be fadeless and to provide a permanent label that can be stripped off one surface and reapplied to another many times without leaving a mark or losing its adhesive quality.

Four standard colors (blue, green, black and red) are available, providing a handy aid to coding, and widths from 5/16 in. to 2 in., in a wide variety of roll lengths, all fitting standard dispensers or those supplied by the manufacturer.

Labeling tape used as flag on electrical wiring

The new tape also has many non-electrical applications.

Select Batteries With a Capacity Curve

Batteries, like anything else, should be selected to meet their job requirements. Here is how a capacity curve can help you pick the right battery

By K. A. VAUGHAN
Supervisor Field Engineering
Gould-National Batteries, Inc.

PROPERLY USED, a battery capacity curve can tell how many and what size batteries will supply a given power requirement. Utilizing such curves, a user can check supplier's recommendations and be doubly certain not to select under-capacity batteries that run down too soon or over-capacity batteries that call for unwarranted initial cost.

Battery capacity, the total amount of energy a battery delivers as its voltage drops from initial to final value, depends on the temperature of the electrolyte and the rate at which the battery is discharged. Discharge rate is measured by the number of hours required to discharge the battery at constant current. Capacity is measured either by ampere-hours a battery will deliver between charges or by current in amperes it will deliver while being discharged. Batteries do not actually discharge all of the energy they store, but are considered to be discharged when their voltage reaches an arbitrary final value, usually taken as 1.75 v per cell.

A capacity curve is the plot of capacity per positive plate versus ampere discharge rate for a given temperature and to a specified final voltage. The curve shown here is drawn for final voltage (FV) of 1.75 v and an operating temperature of 77 F. Hour discharge rates are represented by straight lines through the origin intersecting the curve marked FV.

Finding Plate Capacity

To find the capacity per plate for a particular battery, select an hour-discharge rate and note the intersection of the appropriate hour discharge-rate line with the curve FV on the capacity graph for that battery. The horizontal line through this intersection crosses the vertical axis at the ampere-hour capacity per positive plate. The vertical line through the intersection crosses the horizontal axis at the ampere capacity per positive plate.

For example, suppose that batteries of Gould Type XVL-Z are to be discharged at the 6-hr rate. In the curve, made for this battery, find the intersection of the 6-hr discharge-rate line with the final voltage curve. Following the horizontal line A and the vertical line B shows the ampere-hour capacity to be 40 amp-hr per positive plate and the ampere capacity to be 6.7 amp per positive plate.

Current and duration of discharge determine ampere-hour capacity by the formula: ampere-hour capacity equals current in amperes multiplied by hours of discharge. For greater accuracy, read the larger of these values and convert to the other with this formula. In the example 40 amp-hr, from line A, divided by 6 hr gives an ampere capacity of $6\frac{2}{3}$ amp.

Table I lists values obtained by this method. Capacity curves for various final voltages (in addition to 1.75 v) and tables like Table I are prepared for each industrial battery and are available from manufacturers. In selecting batteries, the ampere-hour capacity requirement for each plant operating shift should be considered as 80 per cent of the actual requirement. In this way ample surplus is assured for future additional power needs.

Initial Voltage

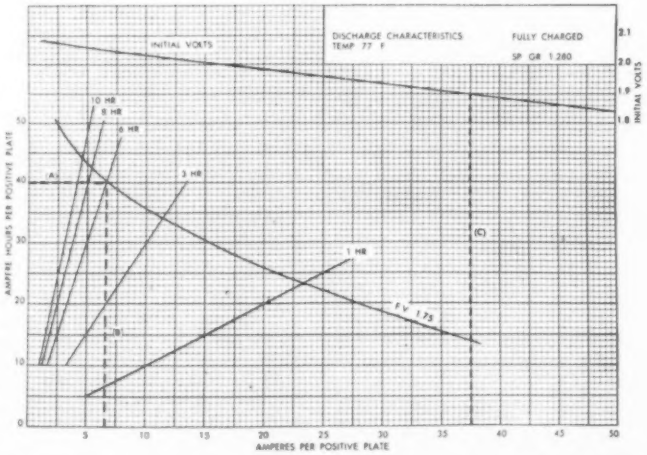
Initial voltage depends on the rate of discharge and can be determined by following the vertical ampere line to the initial voltage line at the top of the graph, and then reading initial voltage from the scale on the right. For example, initial voltage at a discharge rate of 35 amp per positive plate is 1.90 v per cell, determined by following line C in the curve up from 37.5 amp to the initial voltage line. The values in Table II were determined by this method.

Table I. Capacities per positive plate, from the capacity curve, for different hour discharge rates

Capacity Per Positive Plate at 77 F to a 1.75 FV		
Hour Discharge Rate	Amp-hr	Amp
10 hr	44.0	4.40
8 hr	42.5	5.31
6 hr	40.0	6.66
3 hr	34.0	11.33
1 hr	23.4	23.40

Table II. Initial voltages found from capacity curve show variations depending on time and current

Initial Voltage Per Cell at Various Discharge Rates		
Hr	Amp	IV
10	4.50	2.061
8	5.31	2.059
6	6.66	2.050
3	11.33	2.023
1	23.40	1.967



The intersection of known values on the capacity curve gives data vital to selection of proper battery

New Start-Up Method For St. Clair Turbines

By FRANK TABOR
Engineering Assistant
The Detroit Edison Co.

THE INITIAL St. Clair plant of the Detroit Edison Co. will contain four units with no main steam interconnections. Each unit will be composed of an 1800-psi, 1000 F/1000 F reheat steam generator and a cross-compound, double-flow turbine generator.

First, the fact that the steam generators are not interconnected by a common main steam header means that the full 1800 psi rated steam pressure will not be available for start-up. For that reason, the turbine control valves will be opened at about 400 psi to start the turbines rolling. Then, both the steam generator and the turbines will be brought up together. Full rated steam pressure will not be reached until turbines are well loaded. This practice differs considerably from present plant start-up at full main steam pressure.

A second major difference in St. Clair unit start-up, as explained in *Coal to Kilowatts*, is that two generators on separate shafts (3600 and 1800 rpm respectively) will be brought to speed and synchronized with the system. At first glance, synchronization doesn't appear to differ radically from present plant practices. However, the fact that the 1800-rpm turbines will not have an operating governor (only an overspeed device) means that usual control of speed by adjusting steam flow cannot be exercised over the 1800-rpm turbines. For that reason, a somewhat different method will be used to synchronize this machine.

Two Operations Necessary

Actually, two synchronizing operations will be necessary to place the cross-compound units on the system. First, the two generators will be synchronized with one another at turning gear speed and then be brought to rated speed. Second, the unit (both generators) will be simultaneously synchronized with the system to complete the operation.

The entire generator synchronizing procedure will center about a motor-generator set called the starting exciter. With proper start-up steam pressure available and both the 3600 and 1800 rpm turbines on turning gear, the starting exciter will be put into operation and connected to the fields of the two generators. Since the generator stators will be permanently tied together, exciting the fields will cause the generator rotors to align with one another and lock together electrically somewhat like a pair of selsyn motors.

During alignment, one turbine will trip off turning gear leaving the other turning gear to rotate both turbine shafts. Opening the control valves, located on the high pressure machine, will then admit steam to the 3600-rpm turbine causing it to speed up. A short time will elapse before steam exhausted from the 3600-rpm turbine will reach the 1800-rpm turbine. During this interval, the 3600-rpm generator will drive the 1800-rpm generator as a synchronous motor. The generators may alternately motorize one another many times during the starting cycle.

Completing Synchronization

When rated speed is reached, the generator source of field current will be transferred from the starting exciter to the shaft-driven exciters. The starting exciter can then be shut down.

Speed, phase and voltage of the two generators will then be matched with the 120-kv bus and the circuit breaker (only one for the two generators) will be closed to complete the synchronizing operation. Immediately following synchronization, an initial load will be applied to the generators.

Operations described above, except for synchronization, will be performed by the Unit Control room (controlling the boiler and turbines). An operator in the Central Control room (controlling electrical output) will synchronize the generators with the system, apply initial load and then return control to the Unit Control room for further loading. The Unit Control room will then load the generator as rapidly as good boiler operation will permit. Control of unit loading will be returned to the Central Control room as soon as boiler steaming rate ceases to be the limiting factor on further load increase.

An interesting point concerning cross-compound units like St. Clair's is that division of load between the 3600-rpm and 1800-rpm generators will not be under the operator's control. The manner in which the load will divide is fixed by the design proportioning of turbine sizes.

DON'T CLIP THIS ARTICLE
Others in your plant may want to read the complete issue, so if you want an extra copy of this or any other article, ask the Editor for tear sheets or a reprint. For convenience, use the postage-free card that you will find elsewhere in this issue.

Sheet Metal Corner Clamps

By F. E. Riley

HOLDING two pieces of sheet metal together so that their adjoining edges form a right-angled corner is an awkward task. Makeshift packing and supports are often used, but the resulting corner, whether brazed or soldered, seldom looks neat.

Simple clamps for accomplishing the above can be made from pieces of broom handle and have the advantage that light gage metal can be held firmly without conducting heat away from the soldering iron or gas torch.

Two lengthwise saw cuts are made in the round material of the clamps so that they are at 90 deg to one another. The cuts are best made on a circular saw. The two cuts divide the material into two halves forming the clamp which is held together by means of ¼ in. bolt and wing nut.

Packing pieces are inserted in the clamp at its tail end to hold the clamp faces parallel. The packing pieces are made from scraps of material which is to be joined. The clamps are very cheap to make and a large number of them enable complete sheet metal assemblies to be clamped up before joining permanently. Larger versions can be made up from round steel bar material for the purpose of welding clamps.

Riley's clamp made out of a piece of broom handle

Basic Power Plant FIGURING

A Review for Old-Timers—A Must for Young-Timers

By **WILLIAM H. ENGELMAN**
Mechanical Engineer
Cleveland, Ohio

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Physical Characteristics of Schedule 160 Pipe, Needed in Practical Power Plant Problems

All the standard physical data on Schedule 160 pipe, collected on these two pages from standard Tables in many handbooks, data books and catalogs

Saves looking them up in several different places.

KEEP THESE TABLES. You will need them in solving power plant and piping problems.

Table C—DATA ON SCHEDULE 160 PIPE

Nom. Pipe Size In.	Outside Dia. In.	Inside Dia. In.	Wall Thickness In.	Metal Area Sq In.	Weight Pounds Per Ft.	Cross-Sectional Internal Area		Square Feet of Surface Per Linear Foot		Linear Feet Per Sq Ft. of Surfaces		Flow at One Ft. Per Sec. Velocity		Nom. Pipe Size In.
						Sq In.	Sq Ft.							
								Outside	Inside			Gallons Per Min.	Pounds Per Hour	
	D	d	t	A_m	W	A_f	A_f	A_o	A_i	Ext.	Int.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	
½	0.840	0.466	0.187	0.384	1.304	0.1706	0.00118	0.220	0.122	4.547	8.197	0.532	266	½
¾	1.050	0.614	0.218	0.570	1.937	0.2961	0.00206	0.275	0.161	3.637	6.211	0.923	462	¾
1	1.315	0.815	0.250	0.836	2.844	0.5217	0.00363	0.344	0.213	2.904	4.695	1.626	814	1
1¼	1.660	1.160	0.250	1.107	3.765	1.057	0.00734	0.435	0.304	2.301	3.290	3.294	1,648	1¼
1½	1.900	1.337	0.281	1.431	4.866	1.404	0.00975	0.498	0.350	2.010	2.857	4.376	2,190	1½
2	2.375	1.689	0.343	2.190	7.445	2.240	0.01555	0.622	0.442	1.608	2.262	6.982	3,494	2
2½	2.875	2.125	0.375	2.945	10.01	3.547	0.02463	0.753	0.556	1.328	1.798	11.06	5,533	2½
3	3.500	2.624	0.438	4.213	14.33	5.411	0.03758	0.917	0.687	1.091	1.456	16.87	8,440	3
4	4.500	3.438	0.531	6.620	22.51	9.283	0.06447	1.178	0.900	0.848	1.179	28.93	14,480	4
5	5.563	4.313	0.625	9.70	33.00	14.61	0.10146	1.456	1.129	0.686	0.8857	45.54	22,790	5
6	6.625	5.189	0.718	13.32	45.30	21.15	0.14688	1.734	1.358	0.576	0.7364	65.92	33,000	6
8	8.625	6.813	0.906	21.97	74.70	36.46	0.25320	2.258	1.784	0.443	0.5605	113.64	56,880	8
10	10.75	8.500	1.125	34.02	115.7	56.75	0.3941	2.817	2.225	0.355	0.4494	176.88	88,530	10
12	12.75	10.126	1.312	47.14	160.3	80.52	0.5592	3.340	2.650	0.299	0.3774	250.98	125,600	12
14	14.00	11.188	1.406	55.63	189.1	98.30	0.6826	3.665	2.930	0.273	0.3413	306.40	153,340	14
16	16.00	12.814	1.593	72.10	245.1	128.94	0.8954	4.189	3.354	0.239	0.2981	401.90	201,150	16
18	18.00	14.438	1.781	90.75	308.5	163.71	1.1369	4.712	3.778	0.212	0.2647	510.28	255,400	18
20	20.00	16.064	1.968	111.5	379.0	202.65	1.4073	5.236	4.205	0.191	0.2378	631.66	316,100	20
24	24.00	19.314	2.343	159.4	542.0	292.93	2.0342	6.283	5.055	0.159	0.1978	913.06	457,000	24

DATA ON DOUBLE EXTRA HEAVY PIPE (XX) (No Schedule Number)

½	0.840	0.252	0.294	0.504	1.715	0.0499	0.00035	0.220	0.066	4.545	15.150	0.155	78	½
¾	1.050	0.434	0.308	0.718	2.441	0.1479	0.00103	0.275	0.114	3.636	8.772	0.461	231	¾
1	1.315	0.599	0.358	1.076	3.659	0.2818	0.00196	0.344	0.157	2.907	6.370	0.878	440	1
1¼	1.660	0.896	0.382	1.534	5.215	0.6305	0.00438	0.435	0.234	2.300	4.273	1.965	984	1¼
1½	1.900	1.100	0.400	1.885	6.409	0.9503	0.00660	0.498	0.288	2.008	3.472	2.962	1,482	1½
2	2.375	1.503	0.436	2.656	9.030	1.7740	0.01230	0.622	0.393	1.608	2.545	5.531	2,768	2
2½	2.875	1.771	0.552	4.028	13.70	2.464	0.0171	0.753	0.464	1.328	2.155	7.68	3,844	2½
3	3.500	2.300	0.600	5.466	18.58	4.155	0.0289	0.917	0.602	1.090	1.661	12.95	6,482	3
4	4.500	3.152	0.674	8.102	27.54	7.803	0.0542	1.178	0.825	0.849	1.212	24.32	12,170	4
5	5.563	4.063	0.750	11.34	38.55	12.966	0.0900	1.456	1.064	0.687	0.939	40.41	20,230	5
6	6.625	4.897	0.864	15.64	53.17	18.834	0.1308	1.734	1.282	0.577	0.780	58.70	29,400	6
8	8.625	6.875	0.875	21.30	72.42	37.122	0.2577	2.258	1.784	0.443	0.561	115.70	57,900	8

The schedule number of pipe was adopted in 1939 by the American Standards Association (ASA—B36.10). The base for the schedule No. = 1,000 P/S, where P = internal pressure psig and S = the allowable fiber stress psi. Designation of pipe wall thickness by schedule numbers make the terms "light-weight", "standard", "extra-heavy", and "double-extra-heavy" gradually disappear.

The decimal thickness listed for the respective pipe size is the nominal or average wall thickness. The actual thickness may be as much as 12.5% less because of mill tolerances.

COMMERCIAL PIPING in industrial steam power plants, central stations and steam heating plants is mostly covered by Schedules 40, 80, and 160 pipe. Schedules 40 and 80 cover the entire range from ⅛ to 24 in., Schedule 160 from ½ in. to 24 in., and the double extra heavy (XX) from ½ in. to 8 in.

Schedules 20, 30, 60, 100 and 140 are listed in sizes from 8 in. to 24 in., Schedule 120 from 4 in. to 24 in.; however, many of these schedules and sizes are not currently available at the mills. Nominal wall thickness for all schedules and sizes are given on page 200, Tube Turns Catalog.

Pipe Data Sheet A covering Schedule 40 pipe was published in the August, 1949 issue and Pipe Data Sheet B covering Schedule 80 pipe in the September 1949 issue of POWER ENGINEERING.

Here is Pipe Data Sheet C covering Schedule 160 and the Double Extra-Heavy pipe XX (no schedule number). Due to the continuous rise in temperature and pressure, Schedule 160 pipe is being used more every day.

Note:—The term "Wrought" pipe has been used for many years meaning either wrought iron or wrought steel pipe. This has caused much confusion, as there is no wrought steel pipe. The real wrought iron pipe is more expensive than steel pipe and, in ordering, it must be definitely stated as "Genuine" or "Guaranteed" Wrought Iron Pipe, if you want it. According to the Piping Handbook by Sabin Crocker, when the term wrought pipe is used, it means *worked* as in the process of forming furnace-welded pipe from skelp, or seamless pipe from plates or billets. The expression *wrought pipe* is thus used as a distinction from *cast* pipe. The term wrought iron means iron refined in a plastic state in a puddling furnace. It is characterized by the presence of about 3 per cent of slag irregularly mixed with pure iron and about 0.5 per cent carbon and other elements in solution.

In this article, the author explains how the elements of pipe are derived and has also developed constants for simplifying the calculations. The complete practical example shows the application.

(Continued on page 78)

Great credit should be given: The American Standards Association (ASA), American Society of Mechanical Engineers (ASME), American Society for Testing Materials (ASTM), for their continuous efforts, extending over many years, in research, standardization and design of piping, in close co-operation with the manufacturers of piping and fittings.

Manufacturers of pipe fittings have also contributed immensely: Tube Turns, Crane Co., Ladish Co., Midwest Piping & Supply Co., Taylor Forge and Pipe Works, and others have supplied the data for these pipe tables.

Table C—DATA ON SCHEDULE 160 PIPE (Continued)

Nom. Pipe Size In.	Linear Feet to Contain		Pounds of Wat. Per Lin. Foot	Pipe Column at 10,000 Psi		Elements of Pipe			Powers of d		Allowable Working Pressure at			Nom. Pipe Size In.
	One Cu Ft.	One Gallon		P	L	Moment Inertia I	Section Modulus SM	Radius of Gyration Sq R^2	d^5	$d^{2.5}$	150 F	650 F	850 F	
	14	15	15	17	18	19	20	21	22	23	24	25	26	
½	844.6	112.90	0.074	4,000	0.6	0.0221	0.0527	0.0577	0.02197	0.1482	3270	2610	1590	½
¾	390.6	52.21	0.128	6,000	1.2	0.0527	0.1004	0.0925	0.08727	0.2954	3220	2580	1570	¾
1	276.0	36.90	0.226	8,000	2	0.1252	0.1903	0.1496	0.35957	0.5997	3080	2466	1500	1
1¼	136.3	18.22	0.458	11,000	3	0.2833	0.3421	0.2565	2.1003	1.4503	2225	1780	1085	1¼
1½	102.6	13.72	0.608	14,000	4	0.4826	0.5080	0.3375	4.2722	2.0670	2285	1830	1115	1½
2	64.31	8.60	0.970	24,000	5	1.1626	0.9790	0.5308	13.7450	3.7074	2380	1900	1160	2
2½	40.60	5.43	1.54	32,000	6	2.353	1.638	0.799	43.33	6.583	2200	1760	1070	2½
3	26.61	3.56	2.34	46,000	8	5.033	2.876	1.197	124.40	11.154	2180	1741	1060	3
4	15.51	2.07	4.02	68,000	10	13.27	5.90	2.004	480.32	21.916	2130	1706	1040	4
5	9.856	1.32	6.33	100,000	12	30.03	10.80	3.097	1492.40	38.632	2080	1665	1015	5
6	6.812	0.911	9.16	134,000	15	58.99	17.81	4.431	3762.0	61.335	2040	1632	1000	6
8	3.950	0.528	15.80	220,000	20	165.90	38.48	7.555	14679	121.160	2025	1620	990	8
10	2.538	0.339	24.59			399.4	74.3	11.74	44,371	210.2	2055	1640	998	10
12	1.788	0.239	34.89			781.3	122.6	16.57	106,460	326.3	2040	1630	995	12
14 OD.	1.465	0.196	42.61			1117	159.6	20.07	175,290	418.7	2000	1600	975	14 OD.
16 OD.	1.117	0.149	55.87			1894	236.7	26.21	345,480	587.8	1950	1560	954	16 OD.
18 OD.	0.879	0.117	70.95			3020	335.6	33.30	627,390	792.1	1990	1592	970	18 OD.
20 OD.	0.711	0.095	87.82			4585	458.5	41.11	1,069,700	1034.3	1988	1590	968	20 OD.
24 OD.	0.491	0.066	126.94			9455	788.0	59.30	2,687,600	1639.4	1984	1588	968	24 OD.

DATA ON DOUBLE EXTRA HEAVY PIPE (XX) (No Schedule Number) (Continued)

½	2857	386.0	0.022	5,000	0.6	0.0242	0.0577	0.0481	0.00102	0.032	5920	4736	2886	½
¾	971	130.0	0.064	7,200	1.2	0.0579	0.1103	0.0807	0.01540	0.124	5017	4014	2446	¾
1	510	68.3	0.122	10,800	2	0.1405	0.2136	0.1305	0.0771	0.277	4805	3845	2340	1
1¼	228	30.5	0.273	15,350	3	0.3411	0.4110	0.2224	0.5775	0.760	3900	3110	1900	1¼
1½	151	20.3	0.412	18,900	4	0.5678	0.5977	0.3013	1.6105	1.269	3600	2880	1750	1½
2	81	10.8	0.769	26,500	5	1.3110	1.1040	0.4937	7.6700	2.770	3200	2560	1560	2
2½	58.5	7.81	1.068	40,300	6	2.87	2.00	0.713	17.42	4.17	3490	2790	1700	2½
3	34.60	4.64	1.800	54,700	8	5.99	3.42	1.096	64.36	8.02	3155	2520	1540	3
4	18.45	2.47	3.381	81,000	10	15.28	6.79	1.887	311.0	17.64	2800	2240	1365	4
5	11.11	1.49	5.618	113,400	12	33.63	12.09	2.966	1,107	33.27	2550	2040	1245	5
6	7.65	1.02	8.161	156,000	15	66.33	20.02	4.240	2,816	53.07	2500	2000	1220	6
8	3.88	0.52	16.086	213,000	20	162.00	37.56	7.618	15,359	123.93	1950	1560	950	8

Maximum working pressure is based on grade "A" seamless steel piping, ASTM specs. A-106, covering power piping and district heating. The minimum ultimate strength in tension is 48,000 psi, which gives an allowable working strength of 12,000 psi at 150 F, 9,600 psi at 650 F, and 5,850 psi at 850 F. For grade "B" seamless steel piping, ASTM specs. A-106, 25% higher values are used. They are: minimum tensile strength 60,000 psi, allowable working strength 15,000 at 150 F, 12,000 at 650 F, and 7400 psi at 850 F. Information on the meaning of each item and how to use it is given on page 78.

Nomenclatures and Units in Table C for the Properties of Schedule 160 Pipe, as adopted by ASA in 1939

Nominal pipe diameter refers roughly to the inside diameter of sizes from ⅛ to 12 in. inclusive; but for sizes from 14 in. up, the nominal diameter is also actual outside diameter and is always referred to as OD pipe, thus, a 16-in. OD pipe.

ITEM	SYMBOL	EXPLANATION and REMARKS
1.	D	= Outside diameter (OD) of pipe, inches.
2.	d	= Inside diameter (ID) of pipe, inches.
3.	t	= Nominal wall thickness, inches. (See note.)
4.	A_m	= Cross-sectional area of metal in square inches: $= \frac{\pi(D^2 - d^2)}{4} = 0.7854\,(D^2 - d^2)$ ($\pi = 3.1416$)
5.	W	= Weight in pounds per foot: Constant $3.4 \times A_m$. A cubic foot of steel weighs 490 lb and $490 \div 144$ is 3.4 lb for a bar 1 sq in. in area by 1 ft long.
6.	A_f	= Cross-sectional area, square inches, also known as Flow-Area, and equals: Inside diameter squared $\times$ 0.7854 or $0.7854d^2$
7.		Cross-sectional area, sq ft, is $A_f \div 144$
8.	A_o	= Outside surface in square feet per foot of length $= \frac{\pi \times D \times 12}{144} = \frac{3.1416D}{12} = 0.2615D$ (1 sq ft is 144 sq in.)
9.	A_i	= Inside surface in square feet per foot of length: $= \frac{\pi \times d \times 12}{144} = \frac{3.1416d}{12} = 0.2615d$
10.		Linear feet per square foot of external surface is the reciprocal of item 8 or $1 \div$ item 8. (See math tables.)
11.		Linear feet per square foot of internal surface is the reciprocal of item 9 or $1 \div$ item 9.
12.		$\frac{A_f \times 12 \times 60}{231} = A_f \times 3.117$ gallons per minute flowing at a velocity of 1 ft per sec.
13.	Q_1	= Pounds of water flowing per hour at a velocity of 1 ft per sec. $Q_1 = \frac{A_f \times 12 \times 60 \times 60 \times 62.4}{1728} = A_f \times 1{,}560$ lb per hr.
14.		Linear feet to hold one cubic foot = $1 \div$ item 7
15.		Linear feet to hold one gallon: $\frac{\text{item } 14 \times 231}{1728} = \text{item } 14 \times .13368$, since a gal. is 231 / 1728 or 0.13368 cubic foot.
16.	W_w	= Pounds of water per linear foot of pipe is $0.433 \times A_f$. A cubic foot of water at 52 F weights 62.4 lb and $62.4 \div 144$ gives 0.4333 lb for a column of water 1 ft high and 1 sq in. in area.
17.	P	= The stress in axial loading on a pipe, when used as a column, is given at 10,000 psi. The total load can be $10{,}000 \times A_m$. The top and base must be flanged and/or milled and absolutely perpendicular to the neutral axis.
18.	L	= The unsupported lengths in feet where these loads may be applied. For very short lengths, the loads may be doubled. Eccentric loading must be carefully designed by competent engineers.
19.		= The moment of inertia for a pipe section: $= \frac{\pi(D^4 - d^4)}{64} = 0.04909(D^4 - d^4)$ (inches to the fourth power)
20.	SM	= The section modulus for a pipe section: $= \frac{\pi(D^4 - d^4)}{32D} = 0.0982(D^4 - d^4) \div D$
21.	R^2	= Radius of gyration squared and equals $I \div A_m$.
22.	d^5	= The inside diameter of a pipe to the fifth power (d^5) is a very convenient and essential value in calculating pressure drops for steam, water, gas, air, oil.
23.	$d^{2.5}$	= The inside pipe diameter to the 2.5 power ($d^{2.5}$) is a fairly accurate value for the direct ratios of the relative discharge capacities, provided the friction factor for the pipes under consideration is nearly the same. *One should not use pipe area for comparing discharge capacities; it is misleading and wrong.* The following example will show the relationship between areas and the relative discharge capacities of a 4-inch and an 8-inch Schedule 160 pipe. Area of 8-in. pipe is 36.46 sq in. Area of 4-in. pipe is 9.28 sq in. and $36.46 \div 9.28$ gives four 4-in. pipes in area only. Diameter d to the 2.5 power for the 8-in. pipe is 121.2 Diameter d to the 2.5 power for the 4-in. pipe is 21.9 and $121.2 \div 21.9$ is 5.5, i.e., 5.5 4-in. pipes equal the flow in one 8-in. pipe. *Example:* Find size of header required to equal the discharge of a 6-in., a 5-in., and a 4-in. Schedule 160 pipe. Total of $d^{2.5}$ is $61.3 + 38.6 + 21.9 = 121.8$ for the three pipes From the table: $d^{2.5}$ for an 8-in. = 121.2, which is sufficient Considering area only: $21.15 + 14.61 + 9.28 = 45.04$ sq in. On this basis it would take a 10-in. pipe with 56.75 sq in.
24.		At 150 F, the temperature has no effect on the strength of a pipe. This covers hydraulic piping, piping for presses operating on water or oil, and the like.
25.		The ASME Boiler Code uses stress values at 650 F for any temperature below 650 F.
26.		Maximum allowable pressures are given at 850 F since, at higher temperatures, much consideration must be given to the selection of material and the maximum fiber stress to be used. This should be left to competent and experienced engineers. Note the big drop in the maximum allowable pressure with the 200 F temperature rise. This condition increases much faster with rises in temperatures over 850 F.

Allowable working pressure has been calculated by the formula:

$$P = \frac{(t_m - C)2S}{D} = \frac{(0.875 - C)2S}{D}$$

where:

- P = Maximum internal service pressure, psi.
- t_m = Minimum pipe wall thickness in inches. It is $t \times 0.875$ since 12.5 per cent has been deducted from the tabulated value of t to allow for mill tolerances. $(1.000 - 0.125 = 0.875)$
- C = A factor making allowance for corrosion. This value is 0.05 in. for pipes 1 in. and smaller and 0.065 in. for pipes 1¼ in. and larger.
- S = Allowable stress due to internal pressure at the operating metal temperature, psi.

The minimum ultimate strength for Grade A pipe is 48,000 psi and, with a safety factor of 4, the maximum allowable working pressure is 12,000 psi at 150 F. For Grade B pipe, the ultimate strength is 60,000 psi and the maximum allowable working pressure 15,000 psi at 150 F.

These values cover power piping and district heating piping. For Grade B pipe, multiply values in table by 1.25

Further explanation on the use of these tables.

ITEM

5. Weight of pipe must be known for figuring hangers, supports, etc.
6. Area in square inches is volume in cubic inches per linear inch.
7. Area in square feet is volume in cubic feet per linear foot.
8. Very useful in determining linear feet of heating surface in pipe radiators, heating coils, water and steam heaters, etc.
10. Knowing the square feet of pipe required this item gives the linear feet; thus, 100 sq ft of 1½ in. pipe requires 100×2.01 or 201 linear ft.
12. For any velocity, multiply the gpm value in the table by the velocity factor; water flowing in an 8-in. Schedule 160 pipe at a velocity of 5 fps will discharge 113.64×5 or 668.2 gpm.
13. Water is fed to a boiler through a 3-in. Schedule 160 pipe at a velocity of 10 fps. Amount per hour is $8{,}440 \times 10$ is 84,000 lb.

16. Weight of water plus the weight of pipe (item 5) is frequently used for determining hangers, supports, anchors, and for deflection.
Example: A 24-in. Schedule 160 pipe, filled with water, hangs from roof trusses spaced 30 ft. The vertical dead load at the supports is $(542 + 127) \times 30$ is 20,070 lb.
17. A vertical load of 60,000 lb is to be supported by a pipe column 10 ft long. From item 18 it requires a 4-in. Schedule 160 pipe.
19, 20, and 21 are used in engineering calculations for determining bending moments, fiber stresses, deflections, axial and eccentric loading on pipe columns.
24, 25, and 26. According to the ASME Boiler Code, may a 6-in. Schedule 160 pipe (Grade A) be stressed to 2000 psi at 400 F? No. The code specifies stress values at 650 F for any temperature below 650 F.

Practical example on the elements of an 8-inch Schedule 160 pipe showing how each item has been derived and obtained.

ITEM

4. $A_m = 0.7854\ (8.625^2 - 6.813^2) = 21.97$ sq in.
5. $W = 3.4 \times 21.97 = 74.70$ lb per linear foot.
6. $A_f = 6.813^2 \times 0.7854 = 36.46$ sq in., known as *flow area.*
7. $A_f \div 144 = 36.46 \div 144 = 0.2532$ sq ft.
8. $A_o = 0.2615 = 8.625 = 2.258$ sq ft.
9. $A_i = 0.2615 \times 6.813 = 1.784$ sq ft.
10. Reciprocal of item 8 is $1 \div 2.258 = 0.443$ linear feet.
11. Reciprocal of item 9 is $1 \div 1.784 = 0.5605$ linear feet.
12. $A_f \times 3.117 = 36.46 \times 3.117 = 113.64$ gpm at 1 fps velocity.
13. $Q_h = A_f \times 1560 = 36.46 \times 1560 = 56{,}880$ lb per hr at 1 fps velocity.
14. Reciprocal of item 7 is $1 \div 0.2532 = 3.950$ linear feet per cubic foot.
15. $3.950 \times 0.13368 = 0.528$ linear foot per gallon.
16. $W_w = 0.4333 \times 36.46 = 15.80$ lb per linear foot.
17. P is 220,000 lb, the vertical concentric load.
18. L is 20 ft, the maximum length for this loading.
19. $I = 0.04909\ (8.625^4 - 6.813^4) = 165.9$ (inches fourth).
20. $SM = [0.0982\ (8.625^4 - 6.813^4)] \div 8.625 = 38.48$ (inches cube).
21. $R^2 = 165.9 \div 21.97 = 7.555$.
22. $d^5 = 6.813^5 = 14{,}679$.
23. $d^{2.5} = 6.813^{2.5} = 121.16$.
24. Maximum allowable working pressure at 150 F is 2025 psi (100.0%).
25. Maximum allowable working pressure at 650 F is 1620 psi (80.0%).
26. Maximum allowable working pressure at 850 F is 990 psi (48.8%).

It should be noted that the 200-deg temperature rise from 650 F to 850 F caused a drop of 630 psi in the allowable working pressure. This shows clearly the rapid drop in strength with an increase in temperature.

Allowable working pressures for items 24, 25, and 26 are found by the formula given with the proper values inserted, thus:

$$P = \frac{(0.875\ t - C)2S}{D}$$

Where: $t = 0.906$, $C = 0.065$, $S = 12{,}000$, $D = 8.625$

$$P = \frac{(0.875 \times 0.906 - 0.065)\ 2 \times 12{,}000}{8.625} = 2025 \text{ psi at 150 F for Grade A pipe}$$

$2025 \times 0.80 = 1620$ psi at 650 F
$2025 \times 0.488 = 990$ psi at 850 F

For Grade B pipe the allowable working pressures would be:

$2025 \times 1.25 = 2531$ psi at 150 F
$1620 \times 1.25 = 2025$ psi at 650 F
$990 \times 1.25 = 1238$ psi at 850 F

$\frac{15{,}000}{12{,}000} = 1.25$, the factor

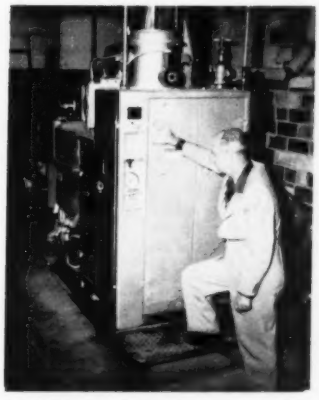
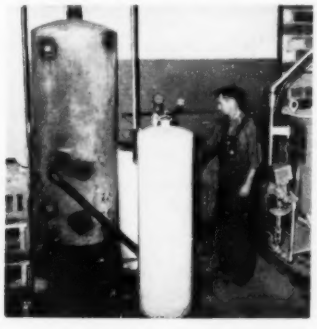


Fig. 1. This new unit generates steam to produce more than 80,000 sq ft of box board per hr

Fig. 2. L to R—blow down tank, Elgin water softening system tank, back side of steam generator



Steam For Box Board

PROCESSING HEAVY kraft paper into tough corrugated box board requires steady steam pressure to give correct temperatures in steam-jacketed cylinders and drying plates of modern corrugating machines.

Recently, The Hoerner Corp. installed a new corrugating machine in their South West Box Co. plant at Sand Springs, Okla. The new machine, which is 307 ft long, processes 80,000 sq ft of box board per hr using 175-psi steam; and up to 100,000 sq ft of box board per hr using 195-psi steam.

To produce this steam the company installed a Vapor-Clarkson steam generator, shown in Fig. 1. The unit automatically produces from 1000 to 5000 lb of 99 per cent dry steam per hr at pressures from 75 to 300 psi. Important advantage is its ability to supply ample high-pressure, dry steam at the single face end of the machine, where adhesion takes place as heavy, 85-in. wide corrugated paper makes contact while traveling at 500 ft per min.

South West Box Co.'s new steam generator was delivered in one crate. A fork lift truck picked up the unit and placed it in the boiler room ready for installation. Older boilers in the plant were tied in to supply additional steam if pressure on the drying plates should go to 140 psi. They will also be used during winter months when paper stock is cold, and to supply part of the building heat load.

Gas-fired, the unit's automatic controls modulate steam output as required. Less than 15 min a day are spent in close attendance to the unit. It develops 200 psi in 2 min, and heats up the entire corrugator in less than an hour.

Water pump on the steam generator takes water from the condenser return tank and forces it into steel coils where steam is generated. About 500 lb of treated feedwater are added to this closed system per hr. Figure 2 shows the Elgin water softening system and blowdown tank. Coils are blown down for about 1 min every 8 hr; condensate is drained off and steam is released to the atmosphere.

Just how much steam is required for a modern box board plant is well illustrated by the following:

(1) Steam for corrugating machines to heat steam-jacketed cylinders, corrugating cylinders and drying plates, to keep adhesive solution hot, and to supply small steam jets directed on paper.

(2) Steam cleaning the machine — a daily preventive maintenance operation.

(3) Steam for heating plant through unit heaters. Pressure is reduced to 20 psi in a 4-in. feedline.

(4) Steam for making starch glue which is cooked in 660-gal batches.

(5) Steam for paraffin wax machine — used to wax-coat cold-storage butter cartons. Steam melts paraffin and heats steam-jacketed rollers in the machine.

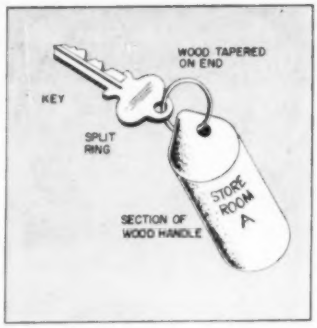
PRACTICAL HINTS AND KINKS

How about the gadget you made or the trick you used to do your job better? Write us about it. Send a sketch too. You will be paid well for contributions.

Key Marker

By JOHN FOSTER

TO HELP prevent misplacement and loss of frequently used keys, a simple but durable marker can easily be made from a piece of discarded hammer, broom or brush handle, as shown. The size of the marker should be such as to make it inconvenient to be put into a pocket.



Key marker by Foster with identification on handle

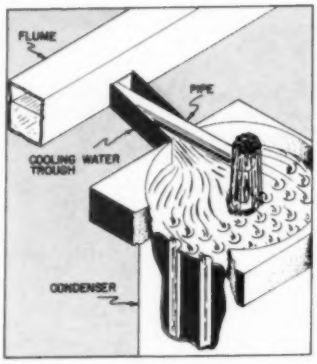
Scrap Pipe Boosts NH_3 Condenser Efficiency by 25%

By SAMUEL R. GREEN

HERE IS a sketch of a vertical shell and tube ammonia condenser in which I have increased the efficiency by 25 to 35 per cent on actual test. I did this by using 4 in. scrap pipe as outlined on the sketch.

The 4 in. pipe comes out of the regular flume gate and extends to the center of the condenser with a 90 deg elbow and a 4 in. nipple 6 in. long. It's supported by a pipe saddle made out of ¼ in. scrap iron, thereby flooding the center tubes of the condenser, which normally runs dry even with excess water going over the condenser.

We also use plastic water distributors to stop corrosion of the tubes and our condensers are bonded to a carbon plate to stop electrolysis from attacking the tube sheet.



Acid Etching Restores Identification Plates

IDENTIFICATION plates on boilers and other types of power equipment frequently became corroded after several years of exposure. As a result, the information they contain is obliterated. In many cases, this information is required for the renewal of either an operating license or insurance coverage for the equipment.

Engineers at Sam Tour & Co., Inc. have used an acid etching treatment for restoring such information on corroded plates. In one such instance, they were called in to determine the identification number on the shell of a steam boiler.

The area in which the obliterated information was known to exist was first cleaned with a solvent to dissolve the layer of surface scale. Then the area was treated with an acidic solution. The identification numbers, dates of previous inspections, and other information required for the issuance of a new license and insurance were then easily legible.

The success of the method depends on the special response of cold-worked steel to acid etching. Thus, because the die stamping of numbers cold works the metal, the numbers can be restored despite subsequent corrosion or abrasion.

Plastic Tapes

By L. W. FITZPATRICK

SMALL thickness plastic electrical tapes, while replacing conventional rubber and friction tapes, are often difficult to remove when resplicing terminals. Simple solution is to make first wrap on terminals with varnished cambric tape, then plastic tape. A knife cut through the tapes and the assembly is easily removed.

Questions and Answers

Your fellow engineers will answer your power engineering questions. You answer theirs, get paid well. Simple? Effective? Why don't you try it?

Question No. 502

What Has Been Your Experience With Fuel Oil Sludge Solvents?

WE OPERATE a small steam generating plant to furnish heat and power to a private school.

Our boilers burn Bunker C oil (or No. 6 fuel) and we have been using a fuel oil solvent to keep the heaters and strainers clear of sludge and also to keep the sludge from settling in the bottom of our tanks.

There are many different kinds of solvents on the market, but we use one that is made locally and gives us excellent results. From time to time, people try to sell us something different, and in so doing get our contract and purchasing sections somewhat concerned as to whether any such material is necessary or not.

In keeping with the above paragraph, we at one time discontinued using the solvent and it was not long before we proved to ourselves that something of the sort was necessary. So again began using this locally-made material and have been out of trouble ever since.

What have been Q & A readers' experiences with sludge solvents when operating under similar conditions? Any letters pro and con would be very welcome.

Southbury, Conn. N. C. A.

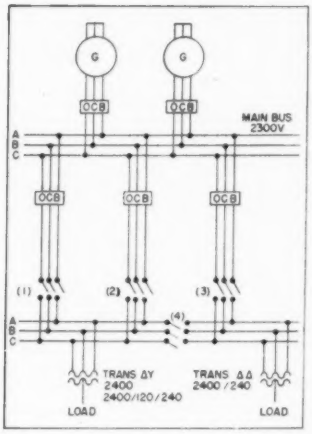
Question No. 503

Why Does This Switch Blade Arc?

THE DIAGRAM on the next page shows the arrangement of one section of our generation and distribution system. Disconnecting switches shown are individual blade type, not gang operated.

With switches 1, 2, 3 and 4 closed, no difficulty is experienced in opening switches 1, 2 or 3 a blade at a time, or if any one of them is open, no difficulty is experienced in closing it one blade at a time.

However, with switches 1, 2 and 3 closed, two blades of switch 4 may be opened or closed with no difficulty, but when an attempt is made to open or close the third blade of switch 4, violent arcing occurs accompanied by serious generator and system disturbances.



J. A. K.'s electric generating and distribution system. With 1, 2 and 3 closed, why does third blade arc on switch 4; first and second do not?

We can readily see why switches 1, 2 and 3 can be operated one at a time because they are definitely in parallel. Heretofore, we considered switch 4 in parallel but it does not perform as such. We would like to have an explanation.

Baltimore, Md. J. A. K.

Answer No. 497

What Can He Do About This Hotwell Pump?

IN THE AUGUST issue M.P. described his plant's new concrete hotwell as built in the basement right on the foundations. A centrifugal pump, installed nearby on the basement floor, takes suction from the bottom of the hotwell. Condensate returns to the hotwell at temperatures between 190 and 200 F. When the hotwell level goes down, the pump begins to cavitate and steam bind and will not pump water from the hotwell to the deaerator.

Response to M.P.'s question continues to be overwhelming. Here are some more answers from readers. Most propose similar, workable and inexpensive solutions — some suggest interesting and workable, though slightly unorthodox, remedies. All should provide M.P. with an exhaustive list of possibilities to overcome his difficulty.

Discussion by Sibley

CONDENSATE RETURNS from process installations are more often than not considerably hotter than the figure M.P. mentions. Usually there is also a considerable volume of flash steam with the condensate.

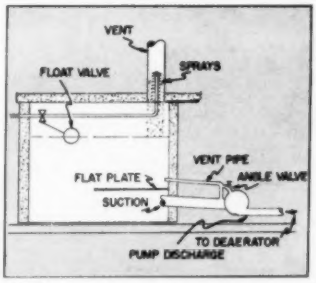
In pumping hot condensate there are several things to keep in mind: eye of the pump impeller must be properly vented; water velocity at the pump inlet must be kept low; submergence or positive head over the center line of the pump must be maintained as high as possible, or water temperature must be reduced.

Quite often something can be done on all of these counts. Extent of work will depend upon results desired. Complete elimination of cavitation, noise and impeller erosion is not necessarily good commercial engineering.

Proper venting of the condensate pump does not mean just venting the top of the pump casing. There should be a vent at this point, but it is of use only when the pump is shut down. Vent required for handling water close to the flash temperature must be located at the top of the pump suction inlet.

Condenser pumps on turbines have tapped bosses for vent connections in the top of each inlet scroll. These are double-suction pumps. A single-suction pump will have a larger than normal inlet and the vent connection will be close to the impeller eye.

If M.P.'s pump is not now vented at the suction inlet he should install a vent line at once, as close to the impeller inlet as possible, and on top of the suction pipe. Vent piping should slope continuously up and back to



Proper venting of the pump is important. Arrangement like this may prevent vapor lock, says Sibley

the hotwell. Properly installed, this will prevent vapor lock in the pump, as shown in sketch.

If the line is short and straight, a ¾-in. line with only one gate valve may be satisfactory. If not, a 2-in. vent line may be required. This is in terms of a 4- to 8-in. suction depending upon the amount of water to be pumped.

Condensate pumps are sized from 1½ to several times the size of cold water pumps of the same capacity. Suction velocities must be kept low. This can sometimes be accomplished in an existing pump by reducing pump speed to the minimum that will supply required discharge head and capacity. An 1800-rpm pump at 1200 rpm will sometimes do the trick. Check the head capacity curves of the pump operated at various speeds.

Control of the pump should be by throttling discharge gradually so there will be no sudden changes in water velocity. Automatic start and stop is not good, and if necessary should be arranged so the control valve will open only slightly when starting up the pump.

Regulation of the control can be from a float in the hotwell; but it is better to regulate from the deaerator requirements, and maintain adequate hotwell level by adding makeup water to the hotwell by float control. This helps cool water being pumped. Water can be added in the form of a spray to condense steam escaping from the hotwell vent.

Hotwell level should be maintained as high as possible consistent with preventing an overflow of condensate returned after the plant is shut down. Hotwells often serve a dual purpose and act as a surge tank in addition to their normal function.

Even chilled water circulating pumps become air bound under low head conditions. Suction piping too close to the surface of the liquid being pumped can create a vortex or small whirlpool so that air is sucked into the inlet piping. Small amounts of air will pass through the pump with the water but if there is too much air a centrifugal pump will just churn.

To prevent a vortex the water level must be high; or, a flat plate can be installed over the top of the inlet pipe to spread the suction and break up the tendency to vortex.

Heat exchangers have been used to take heat out of condensate returns so water can be more easily handled. This works out very well in plants where large volumes of hot water are required for process.

In my opinion it is better to separate high and low pressure returns as far as possible and run high pressure returns directly to the deaerator without control. This will reduce pumping and temperature of water pumped and all flash steam will be utilized.

Jets have been used to create a positive suction head at the pump inlet. Part of the hotwell pump discharge capacity is used in the jet. Installation is similar to a jet deep well pump arrangement.

Waterford, Conn. E. F. SIBLEY

Install Float Valve in Bypass Line

ASSUMING FIRST that there is a level in the hotwell at which the pump operates properly, I would install a float-operated valve in a bypass back into the hotwell.

This method, as used at our plant, is preferable to a float-operated valve in the pump discharge line. . . .

C. D. CRONENWORTH

St. Clair, Mich.

Doubts Wisdom of Concrete Hotwell

. . . I THINK that using a concrete tank for condensate storage is not too good; condensate can pick up some hardness, though perhaps this is not appreciable.

Massapequa, N. Y. C. W. EASTON

Float Control, Says Vogelsang

. . . SUPPLY makeup water to the hotwell by means of a float control. This might necessitate an overflow and drain connection through which some of the condensate and its heat would be wasted but it would eliminate the two causes of cavitation. It is possible that the float level could be so adjusted as to maintain adequate net positive suction head without any overflow. Cost of a float control should be very nominal.

Norfolk, Va. C. W. VOGELSANG, JR

Kuehn Suggests Compressed Air

IF THE HOTWELL M.P. describes can be made air tight and if compressed air is available, a rather unorthodox solution to his problem presents itself. . . .

With the hotwell made air tight he can introduce air over the surface of the water at about 2 psi pressure through a suitable regulating valve which will provide an additional 4-ft head on the suction side of the pump. This will probably be enough to prevent water from flashing as it enters the pump. He must, of course, provide a relief valve or U-leg seal on the hotwell to eliminate the possibility of excess pressure build-up. . . .

Hazleton, Pa. F. W. KUEHN

Finger in the Dike

IN THE AUGUST issue of POWER ENGINEERING I was reading Q & A and I should like to help with Question No. 497. Let's hope it isn't against any rules for someone from abroad to answer questions, but I'm taking the chance. (*Editor's Note: Mein Herr, Sie tuen uns Unrecht!*)

Level of the water at 200 F must be about 8 ft above the pump and the answer, as far as I can see, without digging a pit and within a reasonable cost, is to maintain the hotwell level constantly between 6 to 8 ft. Or better, to maintain water above the level at which the pump starts trouble.

(1) To maintain a *nearly constant* level, a float connected to an electric

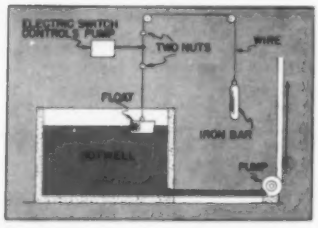


Fig. 1. Intermittent condensate flow arrangement

switch can be installed. Level in the hotwell can be changed by moving the two nuts fastened on the wire, which runs through a hole in the switch lever, as shown in Fig. 1. Switch controls the pump. This method is best if flow is intermittent.

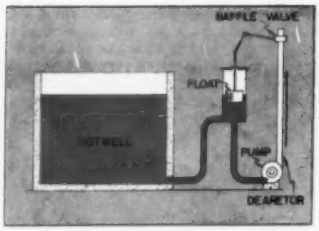


Fig. 2. A continuous condensate flow arrangement

(2) To get a *constant* level, with continuous condensate flow, a floatbank with float can be installed in the suction line of the pump. In the pressure line a home-made baffle valve connected with the float will suffice. If water in the hotwell goes down, the baffle will close a bit, etc. See Fig. 2.

Tiel, Holland L. VAN INGEN

Answer No. 500

How Can He Forestall Diesel Crankcase Explosion?

Comments by Cochrane

C.D.M. DOES not seem to have a clear idea of the causes and effects of a crankcase explosion. Oil vapors are always present in the crankcase of a running engine, but they need a source of heat to ignite them. There is usually enough oxygen present for the initial explosion which may not be a very strong one, but, if oxygen can get in with the remaining hot vapors, the second explosion would very likely be much stronger.

I do not know the make of C.D.M.'s engine but some engines have spring loaded explosion doors which allow the explosion pressure to escape and snap shut again upon recession of this high pressure to seal crankcase against further oxygen entering.

A crankcase breather running from the crankcase to the suction side of intake air blower, or whatever may be on the engine, will keep the vapors in the crankcase at a minimum. Install manometer to show vacuum on crankcase or pressure, if there is any.

The overspeed trip on his engine would have no effect before or after a crankcase explosion. The device he speaks of that shuts down the engine on excessive crankcase pressure may be all right but that is locking the barn after the horse is stolen, because usually the excessive pressure will be that of the explosion. A device that would shut the engine down on excessive cylinder firing pressure would probably be more practical but is no more an answer to the problem than the former.

One place where C.D.M.'s outlook is wrong is that the design of his engine being similar to one that had an explosion does not mean a thing. If that was the case, every diesel man in the country would be frantic.

The best and only way to forestall crankcase explosions is a good preventive maintenance program, and then there is no written guarantee but it will give you a good safety margin. Following are a few tips that will give you that safety.

1. Regular crankcase inspection every 500 to 1000 hr. Check for: Loose, broken, cracked or plugged oil lines and passages. Lack of lubrication will produce high heat and seizures of low clearance working parts, bearings, bushings, bosses, etc. Metal deposits should be traced * to source. Broken bolts replaced.

Spin engine over with crankcase open, watch for blow-by. Broken rings or cylinder out of round will force heated explosive mixtures into crankcase. If piston skirt is visible, check for scoring or discoloration. Feel inside of liner for grooves or rough spots.

2. Check filters and strainers for metal deposits. Clean or change when pressure rises above normal or when they appear to be clogged.

3. Check jacket water passages for scale. If heavy scale is present, call in water treatment concern. It is a good idea to use a continuous water treatment schedule.

4. Semi-monthly or monthly readings should be taken on the following:

Compression pressure — each cylinder at $\frac{3}{4}$ load.
Firing pressure — each cylinder at full load.
Rack reading or equivalent at full load.
Pyrometer reading at full load.

If sharp drops in compression pressures or rises in firing pressures of individual cylinders are noted, a thorough investigation should be made to determine the cause. The readings kept regularly will give a good picture of engine condition over a period of time.

5. Every 8000 to 10,000 hr, pull heads, pistons, rods. Inspect and clean, replace worn or broken rings. Check condition of bearings. Mike liners and pistons, compare with original readings. Factory manual will give allowable maximums of wear. Clean crankcase thoroughly, also clean sump tank if engine has one. Clean strainers, filters and lines. Inspect water passages. Check chains, sprockets. Look for broken bolts, oil lines, etc.

One safety measure to be remembered — never open up the crankcase of a hot engine. Let engine set at least $\frac{1}{2}$ hr after shutting down before admitting fresh air to crankcase. Otherwise you may never know what hit you.

If aforementioned manometer shows pressure, chances are the blow-by past rings are the cause or possibly the crankcase breather is plugged. At any rate investigate.

Milaca, Minnesota DON COCHRANE

*In engine that has operated a few years, some metal will always be present.

Power Show, 1952, To Forecast Power Engineering Objectives

EXTRAORDINARY DEVELOPMENTS in power plants are forecast in plans for the 20th National Exposition of Power and Mechanical Engineering to run in New York through the first week in December. Technical advances of revolutionary nature will be under review at that time at the annual meeting of the American Society of Mechanical Engineers, under whose auspices the Power Show is held, but their reduction to practice will depend very largely on the work of specialists, whose latest achievements will be displayed currently in Grand Central Palace.

Leaders in the engineering profession foresee a doubling of gas consumption within the next decade or two, and competitive improvements in the treatment and combustion of coal to enhance the position of that fuel in regions where it is readily available. More and larger superpower stations are promised for the future and far more economical generation of power in industrial plants, some of which rival the great utility electric generating stations in size. All manner of improvements in power plant economy are being fostered to offset the rising tide of power costs, and many of these will immensely benefit the economy of older and smaller installations.

Of no less moment is the prospect of rapid advancement of the gas turbine, which, many now believe will occupy a dominant position in favorable fields, and which promises to supplement the internal combustion piston-driven engine in automotive power plants, if not to supplant it in the air.

Advance information on some of the displays at the Palace suggests the close touch of the specialist with the scientists and new engineering project developers. One exhibitor will show centrifugal castings of special alloys for jet engines, including a difficult silicon-iron bronze cage blank, cast and hot worked, for antifriction bearings to be used in jet aircraft. In this display will be finished machined centrifugal castings ranging in diameter from 1 in. to 42 in. OD, and in length one-half to 66 inches.

A manufacturer of cast and forged steel products is just bringing out a new and completely revolutionary type of cast steel valve. Another exhibit will be focused on a high-pressure gate valve with breech-lock seal-welded body-bonnet connection, typical of the high-pressure, high-temperature equipment the exhibitor is furnishing to steam generating stations throughout the country. Some of the installations of this type are run at temperatures so high that the valves take on a dull red glow.

Development of a new four-inch tube by a manufacturer of dust collectors permits smaller sized equipment to be assembled, which can be installed in plants where space limitations have prevented the use of such equipment in the past. The exhibit showing this new item will feature an animated display showing fly ash being separated for re-firing. A type of dust collector, first exhibited in this country at the last Power Show, will be demonstrated in action, showing how dust is collected through the aid of 2,000 slotted perforations in each tube. An installation of this type has recently gone into use on a boiler capable of converting 500 tons of water per hour into steam. It handles 450,000 cfm of flue gas at 325 F with a draft loss of only 0.70 in. wg, and is installed ahead of an electrostatic precipitator, which is intended to trap the small proportion of fly ash that escapes the first collector.

Some exhibitors will feature the variety of materials in which the specialties which they produce may be obtained, as tube fittings in brass, steel and stainless, but now also in aluminum. Others emphasize the range of capacities available, as steam traps for pressures from 150 to 2400 psig. There are numerous specialties among the more than three hundred exhibits at the Power Show, such as a catalytic process for treating industrial and potable water without the use of chemicals, which has the function of retarding the formation of scale and gradually, over a period of time, reducing scale and corrosion. A similar instance is the exhibit of a complete system for purifying, dehydrating and degassifying insulating oil in the field or at the central station location.

There will be numerous exhibits of scientific interest and advanced technology. Examples are those of the electron microscope and an adaptation of television to industrial uses involving, among others, the observation of hazardous reactions from remote, safe locations.

The exposition is under the management of the International Exposition Co., with permanent headquarters in Grand Central Palace, New York. Charles F. Roth is manager and E. K. Stevens associate manager.

A general view showing some of the exhibits at the 19th National Exposition of Power and Mechanical Engineering which was held at the Grand Central Palace in New York City during December two years ago

Last spring, the St. Clair power plant thrust itself above the mud. Almost 1,000 tons of structural steel have been erected in the boiler house alone. Work on the foundations for the 120,000 volt switchyard is complete as is the structural steel for the coal breaker house. The turbine base is complete and required the pouring of approximately 1,500 cu yd of concrete. New plant is being constructed by United Engineers & Constructors, Philadelphia

George Porter, Manager of Construction; Al Pasini, Superintendent of St. Clair Plant; W. W. Brown, Project Engineer; and Earle Greene, Construction Engineer, examine a model of one of four main unit cross-compound turbine-generators, each with a capacity of 125,000 kw.

When we said the plant thrust itself above the mud last spring, you can see what was meant. This condition existed on most of the plant site during construction

ST. CLAIR
Grows Every Day

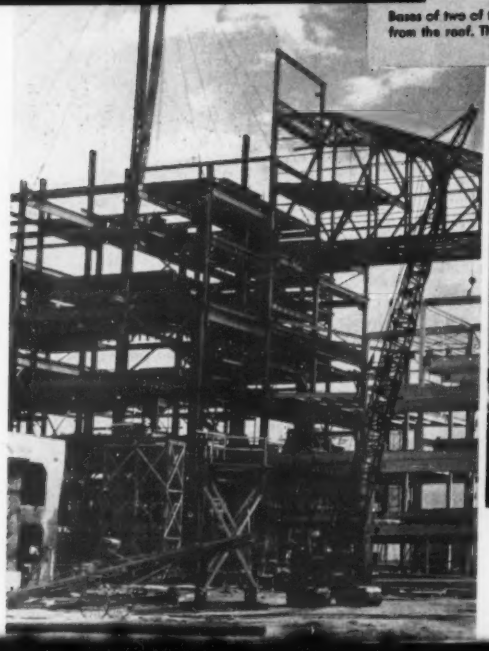
OUTSTANDING among upper St. Clair River industrial construction developments is Detroit Edison's new St. Clair steam electric power plant project.

The new plant, now well under way on the St. Clair River front about 15 miles south of Port Huron, will add some 500,000 kw of electric energy for light and power in the Thumb District and throughout Edison's 7,600-sq mile service area. About 3,500,000 people — half the population of Michigan — dwell in this area.

Decision to build the new plant was a direct result of world events threatening U. S. security and requiring expanded production for defense. Before the outbreak of the Korean conflict, Detroit Edison had intended to add new equipment to the company's Marysville plant, where capacity had already been increased by 200,000 hp since 1943. But, because of space limitations, the adding of new generating equipment at Marysville would have meant retiring three older generators at that plant. The building of the new St. Clair plant made it possible to retain these older generators, thus holding onto more than 90,000 hp.

The total capacity of the new St. Clair plant will be 500,000 kw.

Messrs Porter, Greene, Brown and Pasini examine a model of the station. This model will be on display at the Power Show in New York, Dec 1 to 6 in the POWER ENGINEERING booth No. 12



Bases of two of the 300-ft-high quadruplet stacks which rise sheer from the ground instead of from the roof. These stacks rise alongside the main structure, connected to it only at the base

Know Your

By A. LEVINE
Assistant Chief Engineer
Condenser Service & Engrg. Co., Inc.

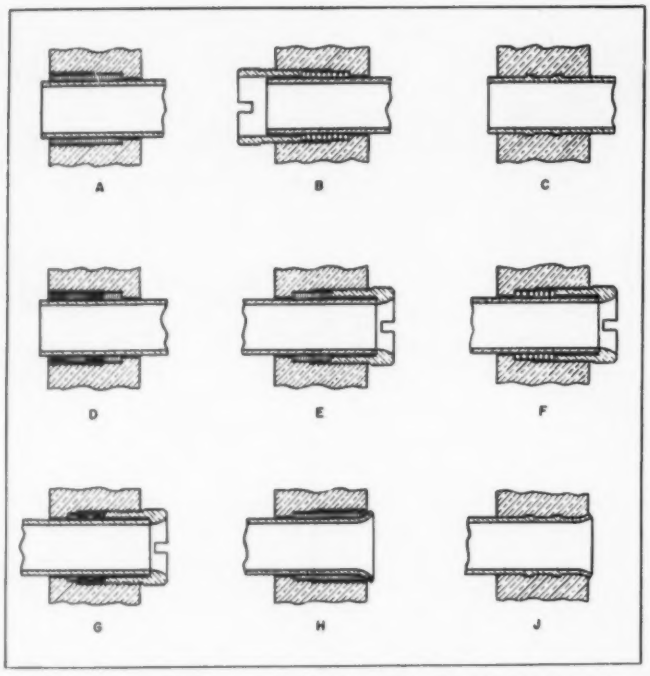


Fig. 1. A to J—Cross-sections of a number of typical expanded and packed tube joints used in power plant heat exchanger equipment. Reasons for using different types are given in the text.

A—Fibre without ferrule, outlet end. B—Corset lace with ferrule, outlet end. C—Expanded joint, outlet end. D—Fibre-metallic joint with ferrule, outlet end. E—Fibre with ferrule, inlet end. F—Corset lace with ferrule, inlet end. G—Fibre, metallic joint with ferrule, inlet end. H—Fibre joint without ferrule, inlet end. J—Expanded joint, inlet end

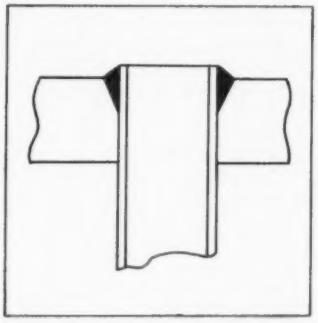
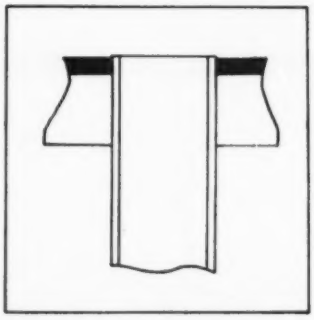


Fig. 2. Cross-section through a welded joint

Fig. 3. Cross-section through a soldered joint



IN YOUR POWER PLANT you have heat exchangers under many names: feedwater heaters, blowdown heat exchangers, heater drain coolers, evaporator condensers, fuel oil heaters, lubricant coolers, air compressor intercoolers, and the like — not to mention the biggest one of all, the steam condenser. These all have tubing of one kind or another, joined in various ways to tube sheets or headers. When you have to do any maintenance work on such equipment, need for intimate knowledge of these joints is obvious.

Primary purpose of a tube joint is to effect a seal between the tube side and shell side fluids in a heat exchanger. A perfect joint maintains this seal throughout the life of the tube without contributing to the normal deterioration of the tube. Since no one available joint is completely satisfactory for all classes of heat transfer equipment, it is evident that mechanical design, operating conditions, and materials of construction of the heat exchanger should be considered before specifying the tube joint.

Types of Joints: — Tube joints can be broken down into two types.

1 — Fixed joints
- Fig. 1 J — Expanded (inlet end); Fig. 1 C (outlet end)
- Fig. 2 — Welded
- Fig. 3 — Soldered

2 — Packed joints
- Fig. 1 F — Corset lace with ferrule (inlet end); Fig. 1 B (outlet end)
- Fig. 1 E — Fibre with ferrule (inlet end); Fig. 1 A (outlet end)
- Fig. 1 H — Fibre without ferrule (inlet end); Fig. 1 A (outlet end)
- Fig. 1 G — Fibre — metallic with ferrule (inlet end); Fig. 1 D (outlet end)

1 — FIXED JOINTS: — Expanded tube joints may be used in all classes of heat exchangers. While better joints are available for certain work, the expanded joint is effective as well as inexpensive. The expanding art is highly developed, with specialized equipment available to give speed and accuracy on the job. The theoretical aspects of expanded joints have been thoroughly discussed in the literature and are well understood in the industry. There are two types of expanded joints, roller and ball.

Roller Expanding: — The roller expander, Fig. 4, is an ingenious tool. The center tapered mandrel is rotated (pneumatically or electrically) between three cage-held rollers. The cage rollers are mounted in slots and have an opposite taper to the mandrel, so that as the mandrel is advanced, the rollers move radially in the cage and the working faces of the rollers always describe a cylindrical surface. The cage is set in the tube end with the stop against the face of the tube sheet. The stop is adjustable so that any depth of the tube can be

Fact is, you have no choice, for correct operation of your power plant depends on proper joints in your many forms of steam, water, oil and air heaters and coolers. And you must know how to handle them in maintenance work. Practically all are fixed joints except for steam condenser

Heat Exchanger Tube Joints

expanded, limited only by the length of the working face of the rollers.

As the mandrel advances, the rollers spin on their own axes and the friction, between the tube wall and roller working faces, forces the cage to rotate. The roller working faces, therefore, continuously roll over the inside periphery of the tube and gradually expand the diameter.

Disadvantages in Rolled Joints: — Several disadvantages are inherent in rolled joints. When the tube is increased in diameter, it also decreases in thickness. Further, a shoulder of small radius is left just behind the tube sheet. The slippage between roller and tube surface causes flaking and cold working at right angles to the grain structure established by the longitudinal draw during the tube manufacturing process. The anneal is partially destroyed and the tube end, particularly at the shoulder, is left in an abnormally-stressed condition. Any sustained vibration picked up from nearby machinery will, in a short time, cause failure of the tube at this point. In an effort to decrease the amount of tube diameter expansion required to make a tight joint, a series of parallel rings (commonly called serrations) is machined into the tube sheet.

Control for Over-Rolling: — Automatic torque controls, electronic and mechanical, have been developed to prevent over-rolling. Motor torque required to satisfactorily expand a tube of given size, material, and hardness, is experimentally determined and this value is set on the machine. The control will automatically stop the expanding process when the proper torque is reached. It is obvious that the tube holes must be machined to close tolerances and the tubes themselves must be of homogenous material and equal hardness.

For the manufacture of new equipment, torque control has reduced tube expanding from a highly skilled individual art to a simple shop operation. For retubing work, however, it is not very satisfactory, especially on old equipment that has been retubed several times. In such cases, the tube holes are enlarged and out of shape. A highly skilled man with plenty of "feel" is required to successfully retube such a unit.

Ball Expanding Is Better: — Another expanding technique is the split ball expander, Fig. 5. Here a split ball is mounted on a short tapered mandrel. In collapsed position, the ball just fits the inside diameter of the tube. When the ball is forced open by longitudinal motion of the mandrel, it expands the tube into the sheet. Over-expanding is impossible because the maximum open diameter of the ball is set by the length of the mandrel taper. Since the tube is expanded by longitudinal motion only, the shoulder left in the tube is of large radius and there is no distortion in the grain structure or flaking of the tube material. Since the ball is spherical, there is no possibility of distorting the tube sheet hole. The movement of the mandrel is accomplished by pneumatic hammer. Before the ball expander can be used, the tube end must be slightly flared to prevent the tube being jarred from the tube sheet.

Ball expanding is cheaper than roller expanding, and tool life is much longer. Although it does not have the handling flexibility of roller expanding, holding power is not affected by tube hardness and no great skill is required in manipulation. Because the ball is spherical and its size fixed for each tube size, the tube holes must be accurately machined, and this technique, therefore, can not be used in retubing work where the tube holes are enlarged or out of shape.

Tube Sheet Material: — Choice of tube sheet material is very important. It must be harder than the tube, otherwise the hole will become enlarged as the tube is expanded. It should be remembered that, in most exchangers, the bridge wall left in the tube sheet between tube holes is quite small,—$\frac{1}{8}$-in. for $\frac{3}{4}$-in. OD tubes; $\frac{1}{4}$-in. for 1-in. OD tubes; $\frac{3}{8}$-in. for $1\frac{1}{4}$-in. OD tubes. If the tube sheet is softer than the tube, there is great danger of weakening the bridge wall or of progressively bowing the sheet as more and more tubes are rolled. On large, light tube sheets, such as those used in steam condenser work, several tubes are rolled in different sections of the layout in order to help stay the sheets and prevent bowing.

Welded or Soldered Joints: — Little need be said concerning welded or soldered joints. Both are expensive

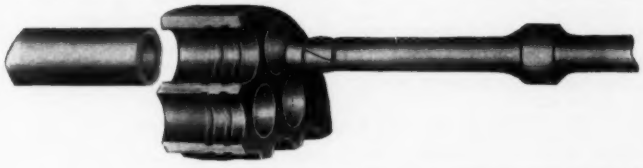


Fig. 5. Split ball expander in which split ball, mounted on mandrel, fits inside tube. The forward movement of the mandrel forces ball open, expands tube into the sheet

Fig. 4. Two types of roller tube expander. Tapered mandrel rotates about three cage-held rollers. As mandrel advances, rollers spin and expand tube diameter

techniques compared to expanding and should be used only under special circumstances. Where lethal or explosive fluids are being handled, it is imperative that no leaks occur during the life of the exchanger. In some cases, leakage of a heating or cooling medium into the product would ruin the product. In these instances, welded tubes can be used to advantage.

Soldering is mainly used in very small exchangers, such as lube oil or jacket-water coolers for low-power diesel engines. Cost of dismantling and retubing these units is higher than buying a new one.

In either soldering or welding, it is customary to lightly expand or pin the tubes to the sheet in order to hold them in place during the sealing operation. Welding is normally used on large diameter steel tubes; soldering on small diameter copper or copper alloy tubes.

Special preparations are necessary before soldering. The entire tube sheet should be thoroughly tinned and wiped. The tube end should be tinned for a distance of approximately twice the tube-sheet thickness. All parts must be clean. Heat required depends on the type of solder used and joint tightness is determined by the solder being drawn by capillary action between tube and tube sheet.

Differential Expansion With Fixed Joints: — If operating temperature differences in an exchanger are large, provision must be made for differential expansion between tubes and shell in order that no abnormal stresses be set up in the structure. If the tube joints are of the fixed type as described above, the exchanger must be arranged with bowed tubes, shell-side expansion joint, packed head, or floating head construction. A discussion of the advantages of each type will be found in an article — Heat Exchanger Costs; Selection and Maintenance, *Plant Engineering*, April 1949. Expanded or welded tube joints can be used at any temperature encountered in present day process or power plant work. Soldered tubes must be used at operating temperatures considerably below the melting point of the solder used.

2 — PACKED TUBE JOINTS: — Packed tube joints have been devised to allow differential expansion between the tubes and shell of an exchanger without complicating the structure with expansion joints, bowed tubes or floating heads. A packed joint is essentially a stuffing box mounted in the tube sheet in which the tube can move longitudinally without breaking the seal. It should be compact and should not depend on glands for maintaining tightness. The arrangement must be such that when tight on test, it should remain tight for long periods without attention. Since the packing medium will be continuously exposed to the exchanger fluids, it must be chemically stable, inert, resistant to rotting, and able to withstand temperature changes.

Limitations in use of Packed Joints: — Installation of a stuffing box around a tube, no matter how small, forces the designer to widen the tube pitch beyond the minimum necessary in the tube sheet for structural strength. For example, a $\frac{3}{4}$-in. OD tube requires a $1\frac{5}{16}$-in. pitch leaving $\frac{5}{16}$-in. bridge wall between tubes. To install a stuffing box requires a minimum $1\frac{1}{16}$-in. pitch, leaving $\frac{5}{16}$-in. between tubes. The shell side fluid in the first case flows through a $\frac{3}{16}$-in. gap between tubes, and in the second case through a $\frac{5}{16}$-in. gap. For an exchanger with no change of phase in the shell side fluid, the smaller the tube pitch, the more effective the exchanger. This consideration alone bars the use of packed tube joints in this class of unit.

Tube Spacing: — In general, wide tube spacing is used to aid in distribution and penetration of condensing vapor in a tube bundle in order to maintain the condensate at the same temperature as the incoming vapor. In process work, where the hot fluid gives up its heat to a cold fluid being used in the process, the temperature difference between vapor and condensate is relatively unimportant from the standpoint of efficiency, because whether the condensate becomes subcooled or not, the heat given up by the vapor is picked up by the process. Penetration and distribution are of secondary importance, except that all the heat transfer surface be effective, and close tube spacing can be used.

Furthermore, in most process plants, one of the major maintenance problems is fouling of the exchanger. The shell side may have to be cleaned 100 times before a retubing is necessary. Under these conditions, a floating head, removable bundle unit is dictated by the process conditions. Since the floating head also allows differential expansion, packed joints become unnecessary.

Packed Joints for Steam Condensers: — In view of the considerations discussed above, practically all types of exchangers are built with fixed tube joints, with the sole exception of power plant steam condensers. They will be covered in detail in a subsequent article.

AEC Power Project 1,200,000 Kw

OHIO VALLEY POWER CORP., Portsmouth, Ohio, is being formed by a group of 15 utility companies, to construct and operate two steam-electric generating plants in Ohio Valley area, to furnish electric power for new uranium plant of Atomic Energy Commission, to be situated at Piketon, Ohio. Power stations, as now projected, will have a gross capacity of 1,200,000-kw., and will be located on sites to be determined near the Ohio-Kentucky border. One plant will be equipped for a rating of 800,000-kw., divided into four 200,000-kw. units, and other with capacity of 400,000-kw., formed of two 200,000-kw. turbine generators. Entire development is reported to cost approximately $280,000,000, including steel tower transmission lines and other field structures, with power substation at plant site. Power companies to be affiliated in project include Ohio Power Co., Canton, Ohio; Indiana & Michigan Electric Co., South Bend, Ind.; and Appalachian Electric Power Co., Roanoke, Va., all subsidiaries of American Gas & Electric Co., New York, N. Y.; Monongahela Power Co., Fairmont, W. Va.; Potomac Edison Co., Hagerstown, Md.; and West Penn Power Co., Pittsburgh, Pa., all affiliates of West Penn Electric Co., New York, N. Y.; Cincinnati Gas & Electric Co., Cincinnati, Ohio; Louisville Gas & Electric Co., Louisville, Ky.; Kentucky Utilities Co., Lexington, Ky.; Ohio Edison Co., Akron, Ohio; Dayton Power & Light Co., Dayton, Ohio; Toledo Edison Co., Toledo, Ohio; Columbus & Southern Electric Co., Columbus, Ohio; Pennsylvania Power Co., New Castle, Pa., affiliated with Ohio Edison Co., noted; and Southern Indiana Gas & Electric Co., Evansville, Ind. Ebasco Services, Inc., 2 Rector St., New York, N. Y., is consulting engineer for project, and will prepare plans for generating plants. Bids for different branches of work are expected to be asked in near future.

New Kearny Units for 2350 psig, 1100 F

WORK IS PROGRESSING rapidly on the construction of the new generating plant of Public Service Electric and Gas Company, adjacent to its present Kearny Generating Station.

The installation consists of two 145,000-kw turbine generators, larger than any units of this type now in service. Each turbine will be supplied by high-pressure, high temperature steam at 2350 psi, 1100 F, and 1050 F reheat, by a single boiler capable of evaporting 525 tons of water per hour. These boilers will use the principle of pumped circulation of the water through the steam producing tubes. This is one of the first installations of this design in this country, although installations of smaller capacity have been used in Europe for many years. Each boiler will be equipped to burn either pulverized coal or oil, and will consume approximately 1200 tons of coal or 5200 barrels of oil daily.

The output of the generators will be carried through four large three-phase transformers and underground oil-filled pipe-type cable to the 132-kv outdoor substation.

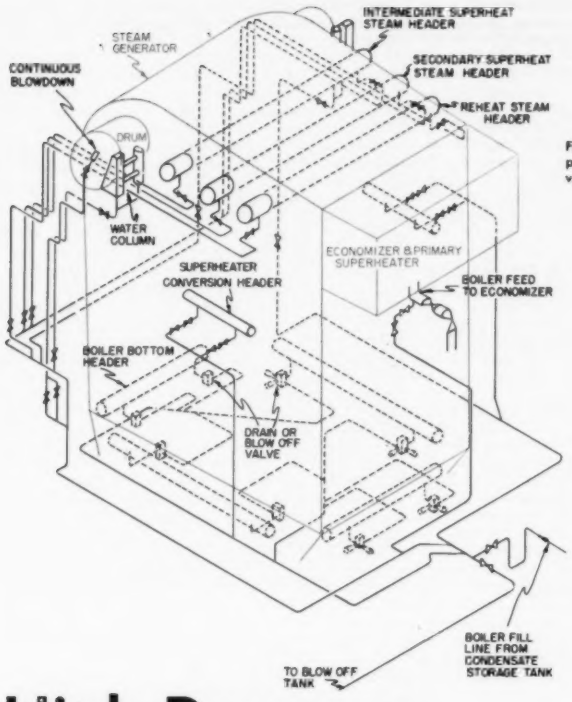


Fig. 1. Diagram shows practical, efficient arrangement for high-pressure boiler blowoff, blowdown and drains. Drains are single-valved near sources and separately carried to operating level

By **HENRY de SOTO**
Consulting Engineer

High-Pressure Boiler Blowoffs and Drains

Boiler blowoff actually functions as a drain in modern high-pressure steam generators. Piping for such systems, says the author, demands careful engineering. Here's why!

PURPOSE OF THE boiler blowoff has always been to provide a safe way to blow out water in the boiler while under pressure. All accepted codes require installation of two valves, separately or in tandem — one acting as a valve, the other as a cock, and providing a slow and quick opening combination. Required location is at the bottom of the boiler and, generally, more than one blowoff connection is required.

However, the coming of high-pressure and temperature steam generators has brought about a change in the actual purpose of blowoff. Tempered by regional codes, this change has come about in a manner hardly noticed by the casual observer of power plant development.

In short, the blowoff has become a drain. Modern practice has made it necessary, or expedient, to so modify the original function of the blowoff for quick discharge of boiler water under pressure. Very efficient water treatment methods and high emphasis put on water sampling are the immediate causes of such a change. Modern steam generators with high pressures and temperatures do not require blowoff to discharge residues and impurities in boiler water. Water sampling and conductivity readings direct removal of carryover solids through use of continuous or intermittent blowdown at the boiler drum.

High-Pressure Drains

Figure 1, showing high-pressure boiler blowoff, blowdown and drains, is a clear guide to efficient, practical design of piping for a modern blowoff system.

Drains at both ends of the secondary (main) steam header, intermediate superheat header, and reheat header are single valved at a place close to the sources. They are independently carried to a point conveniently chosen as an operating station where a second valve is provided for each line. From this junction, each discharges into a common header leading to the blowoff tank. Some designers favor a double valve at the source to safeguard against shutdown if the single valve should leak.

It is good procedure to use an acceptable chrome-moly alloy for drain piping for about 20 ft from the source. High temperatures radiating through the pipe during the operating process, even when no drainage occurs, make this wise. In computing expansion of these alloy lines it is well to remember that chrome-moly steel alloy piping needs no higher expansion multiplier per degree F than carbon steel pipe, and that thermal conductivity characteristics are higher than carbon steel lines. High pressures make mandatory the selection of double, extra-strong pipe for all drain lines.

Since drain valves for the second-

ary (main) steam superheater header normally remain open until steam approaches operating pressure and temperature, this vital line must be of chrome-moly steel until it joins the horizontal header at the operating level.

Modern Blowdown

Need for blowdown, whether continuous or intermittent, is defined by foam conditions in the boiler water. Efficiency of the treating system determines proper blowdown. Modern plants find it extremely worthwhile to facilitate the use of intermittent blowdown by installation of elaborate water treating systems engineered to attain 0.5 ppm total solids or less as measured by usually reliable conductivity methods. Present design of high pressure drums with cyclone separators and primary steam scrubbers guarantees exceedingly high purity steam under widely varying conditions. Effect of cyclones is maximum retention of solids in the circulating water and their removal before steam enters the scrubbers. Major purification of the steam is done in the main steam scrubber conveniently arranged inside the drum.

Continuous, or intermittent, blowdown requires piping in constant operation under saturated steam pressure and temperature. This line, single-valved at the source and the operating level, must also be of extra-strong material, although not of chrome-moly steel alloy. Double valves at the source would be best because of the high pressures.

Single valve at operating level should be by-passed by a smaller globe valve for throttling. This avoids pipe vibration if the full force of the blowdown should contact the temporarily cold line.

Water column and gage glass must be similarly designed. Modern high pressures require a double, extra-strong pipe in this service. Joining of drains from these sources into a single line near the sources, single- or double-valved, is acceptable. At the operating level another valve would assure safety and conform with power piping practices. Thrice daily minimum operation of the line is also important.

It must be remembered that high pressure drain lines should be designed according to the differential of pressures and temperatures of different headers. Many designs commit the error of joining all drain lines into a common receiving header at a point too close to the sources. The main steam header drains have an exceedingly high temperature, being superheated, and are of quite high pressure. Intermediate header drains are of lower temperature and higher pressure. Reheat header drains are of lower pressure and of as high a temperature as main header drains. The fact that pressures in high pressure drain lines are almost as high a short distance from the sources and are not reduced to atmospheric pressure as soon as they discharge, as usually believed, makes these observations important.

Start-up of many steam generators can be complicated by by-pass of higher steam pressures from saturated-steam headers to superheated-steam headers, and by by-pass of high temperatures into carbon steel pipe lines, eventually causing graphitization of such lines.

Tandem valves are the most practical for blowoff lines from the bottom boiler headers. Intended originally for blowing down boiler water under pressure, all codes require a double valve. However, as used in modern steam generators these provide primarily for drainage to condensate tanks or for boiler fill from condensate tanks.

EDITOR'S NOTE: — *See also Will Your Blowoff Valves Stand the Acid Wash?, July issue, page 78, for discussion of effect of chemical cleaning on blowoff valves.*

Starting operation of steam generators is a cracking, repeated opening and shutting, of drain and vent valves until operating pressure is obtained. Design of high-pressure drain systems therefore becomes very exacting.

Size of Drain Lines

Sizes of different lines at the sources are generally 1 in. for all except the continuous blowdown line which is often 1½-in. It is wise to increase these lines a half size just past the source valves and until their junction with the common header, which must have a capacity to receive all lines if opened simultaneously and capacity for the expanding volume of steam and water at that point. From there on, as drains from all sources on both sides of the generator gather and increase in capacity, size of the header must again conform with requirements as total drainage of blowoff and drains demands.

Figure 1 also shows expansion loops and provisions for vertical and lateral expansions of the generator and lines. Anchors, guides and hangers must be provided for these expansions.

Bottom boiler blowoff (drain) lines present very intricate problems of hanging and anchorage. Since there are no structural members at this part of the boiler, fastening of support clamps, or wedged plates at and between the bottom boiler make-up tubes provides a solution to this problem. Boiler bottom headers also can provide a place to weld supports for blowoff lines below them. Boiler manufacturers often allow for such practices since these headers are of very thick steel.

Advantages of these provisions are twofold, not only making pipe hanging easy; but also taking advantage of boiler expansions, which are the same for the lines, therefore making the use of rod hangers and flexible struts acceptable, as shown in Fig. 2.

How to relieve the drain line, extending a distance from the bottom boiler header, of combined elongation and stress caused by temperature and the heavy tandem blowoff valve is often a problem. Figure 3 shows a practical and acceptable solution.

Expansion loops, as shown in Fig. 1, enable drain lines to be supported with rod hangers from steam headers, or from plate casing enveloping their ends, at points beyond the loop. Loops take care of vertical expansion. At a convenient point, as the lines become vertical, a series of anchors will help to sustain their drop, which should be guided to structural members to avoid vibration as they receive discharge from the headers. Other horizontal runs should be spring-supported to allow for expansions, which because of additional anchors may be upwards, downwards or lateral.

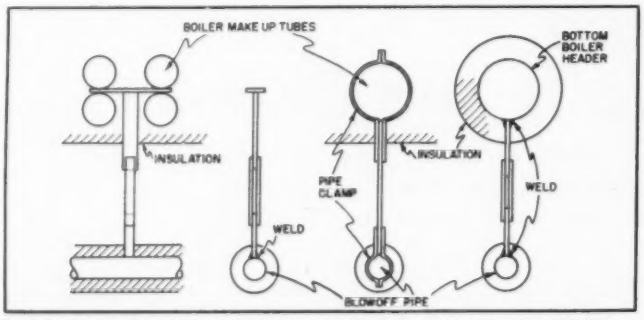


Fig. 2. Flexible struts from make-up tubes or bottom header can be employed to support blowoff pipes

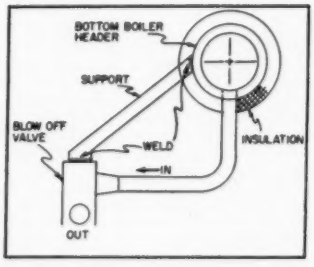


Fig. 3. Welded support will relieve strain on drain line from header caused by heavy tandem valve

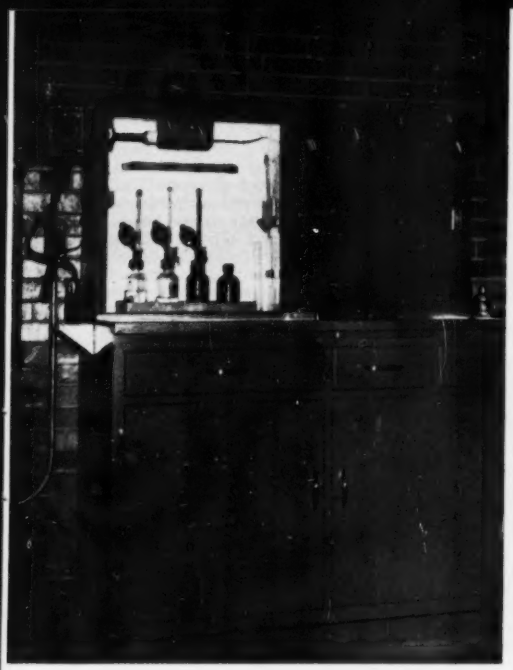


Fig. 1. Water testing cabinet for burette-type equipment, designed by state engineer, encouraged accurate sampling data

FEEDWATER HANDLING

Is Planned in Illinois State Power Plants

A unified program of feedwater treatment in 40 Illinois State power plants has resulted in complete acceptance by engineers, virtually no corrosion or scale, and overall increased plant efficiency. Here's the what and how

By RUSSELL W. LANE

Illinois State Water Survey

ILLINOIS STATE WATER SURVEY has supervised, since November 1949, the treatment of boiler feedwater in Illinois State institutional power plants. This service was originally requested by the Purchasing Agent of the Department of Finance in order that specifications might be provided and competitive bidding arranged in the purchase of boiler feedwater treatment chemicals. Since that time, the success and complete acceptance of the program has been demonstrated by the decrease in boiler scale and corrosion, and virtual absence of resultant tube replacements. Over-all efficiency has also been increased. There are, however, many features which require further efficiency increases and maintenance decreases.

During the first few months of this program, a plant survey consisting of a 13-page form report was made in order to obtain complete information on the water treatment needs of each individual plant. These surveys included complete information relative to boiler plant equipment, operating data, make-up water, water softening equipment, and present problems correctable by water treatment.

After obtaining this information, general treatment formulas, Table I, were designed to provide correct chemical treatment for each indivual plant. The organic blend formula composed of sludge conditioning, scale prevention and anti-foam agents, has been used in conjunction with external softening treatment or with internal softening chemicals, such as caustic soda and disodium phosphate, and with an oxygen scavenger (sodium sulfite).

Table I. General treatment formulas designed to provide correct chemical treatment for plants

Organic Blend	Per Cent
Soda Ash	5–15
Chestnut Tannin	67.5–75
Sodium Polyphosphate	7.5–12.5
Polyamide or Polyhydric Alcohol type Anti-foam, or equivalent	2.5–7.5
Phosphate Blend	
Disodium Phosphate anhydrous	75–80
Corn Starch, powdered	20–25
Domestic Boiler Blend	
Soda Ash	25–30
Disodium Phosphate	25–30
Sodium Sulfite	20–25
Sodium Polyphosphate	4–7
Chestnut Tannin	8–12
Corn Starch	5–10

The phosphate blend formula has been employed in cases where its superior coagulative ability is required. The domestic blend formula has been used as a complete treatment for smaller power plants in which handling of many different chemicals would be inefficient and inconvenient.

Proper testing and control of boiler feedwater treatment has been found to be an extremely important part of this program. Burette type testing equipment, illustrated in Fig. 1, in neat conveniently designed cabinets, has provided an accurate means of testing and has been instrumental in encouraging the operator to provide accurate data.

Testing and Control

Use of electric conductivity testers for determining dissolved solids content has been extremely important in obtaining efficient blowdown. Reproducibility of results with these instruments is good and maintenance low. The chloride test, which had previously been used generally for blowdown control, often provided inexact control since inconsistent and inaccurate results were obtained by different personnel. Errors in determination of the chloride content of the boiler water of 10 ppm were not uncommon. Such errors have provided irregular and inefficient blowdown control particularly in the case of boiler waters containing chloride contents of only 20 to 100 ppm. Such chloride contents are rather common in boiler waters as many make-up waters contain chloride contents on the order of only 2 to 15 ppm.

Each plant has been provided with a boiler water control chart which describes necessary tests and lists proper range of P alkalinity, phosphate, sulfite and dissolved solids content to be maintained in the boiler water samples. When these charts are located conspicuously near the testing equipment, they have

been found to be of considerable help in obtaining proper testing, blowdown and over-all control. Internal treatment methods used are shown in Table II.

Frequent plant visits in which consultation is held with operating personnel have been an important function of this program. Evening classes are held to discuss boiler water treatment, testing and control. These classes are important to the program since continued interest in the maintenance of good boiler water conditioning is retained in this way.

Blowdown

One of the essentials of good boiler water conditioning has been found to be the efficient use of blowdown. Continuous surface blowdown has been installed in all boilers. Oversized blowdown valves were often found to have been installed, requiring the engineer to operate with a closed valve for considerable periods or to operate with such a small aperture that frequent plugging occurred. Replacement with smaller valves has been advocated, so that blowdown flow will be approximately one half the maximum flow of the valve.

Proper application of chemicals has been provided by installation of automatic electric feeding systems (Fig. 2) and has served an important role in the simplification and accuracy of control and in the successful results of treatment.

Scale Prevention

Maintenance of a low hardness in boiler feedwater is known to ensure cleaner feed lines and cleaner boilers, therefore close attention has been directed toward the regeneration of zeolite softeners and to the control of the lime-soda treatment. Proper salt brining, rinsing of zeolite softeners and frequent testing of the effluent has been found to be beneficial. Reduction in make-up water usage by employing practices of conserving all condensate supplies has been found to improve scale prevention by providing boiler feedwater of lower hardness content. Proper blowdown, both continuous and manual, has been found necessary to maintain sludge concentrations below levels which will cause serious adherent sludge deposits. In general, suspended solids or sludge concentrations have been maintained below 1700 ppm in the case of coagulation type treatment, and below 850 ppm in the case of phosphate residual type treatment. Maintenance of oil contamination below three per cent of the suspended solids content has been found necessary to prevent formation of adherent sludge deposits.

Since evidence of pitting and much iron was observed in boilers having been out-of-service, attention has been directed toward proper storage methods. After consultation with boiler inspectors, it has been decided to advocate dry storage employing quick lime for all boilers, excluding those with superheaters. Boilers having superheaters cannot be properly stored by the dry method so the wet method, employing organic blend, caustic soda and sodium sulfite, is being advocated for these boilers. Chief problems which have been encountered in properly storing boilers has been the prevention of leakage of water through defective valves into the stored boilers and the prevention of leakage of blowdown valves in the case of boilers stored by the wet method. Installation of blind flanges has been found necessary in some cases to prevent leakage into the boilers.

Corrosion Prevention

Efficient deaeration, as provided by feedwater heaters, has been found to be of considerable importance in the control of corrosion in the preboiler system, boiler proper, and condensate return lines. Considerable attention has been directed toward attaining this performance. In several plants, the thermostatic valve in the vent line of the feedwater heater was found to be located so close to

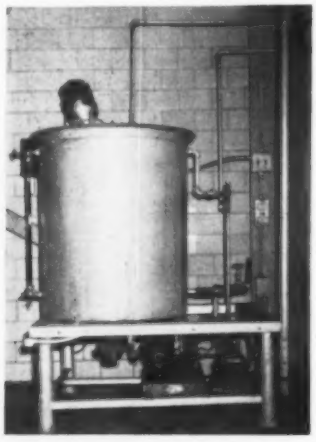


Fig. 2. Automatic chemical feed system uses one pump, another serves as a spare. Note compactness of the unit, arranged by state engineer

Table II. Coagulation and phosphate residual internal feedwater treatment methods prescribed by State

	Boiler Water Composition
I. Coagulation Method (feedwaters of Hardness (as $CaCO_3$) > 60 ppm)	
A. Carbonate type	
Organic Blend	90–140 ppm (Theo.)*
Caustic Soda or Soda Ash	200–350 ppm P Alky. (as $CaCO_3$)
Sodium Sulfite	20–40 ppm (as SO_3)
B. Partial phosphate type	
Calcium (as $CaCO_3$) > 80 per cent of Hardness, Silica > 5 ppm., and/or oil contamination.	
Organic Blend	90–140 ppm. (Theo.)*
Caustic Soda or Soda Ash and Phosphate Blend (1:1)	200–350 ppm P Alky. (as $CaCO_3$)
Sodium Sulfite	20–40 ppm (as SO_3)
II. Phosphate Residual Method (feed waters of Hardness < 60 ppm. and/or Silica > ⅓ Magnesium (as $CaCO_3$)	
Organic Blend	100–300 ppm (Theo.)*
Disodium Phosphate	30–60 ppm PO_4
Caustic Soda	200–400 ppm P Alky. (as $CaCO_3$)
Sodium Sulfite	20–40 ppm (as SO_3)

* Theoretical organic blend content in the boiler water is obtained as follows:

Feed water dosage (ppm) × number of concentrations in boiler water.
Feed water dosage range from 2 to 10 ppm., depending on the following factors:
(1) Type of treatment being applied
(2) Percentage of blowdown
(3) Hardness content of the feed water
(4) Extent of adsorption of tannin on sludge (precipitated hardness) content.

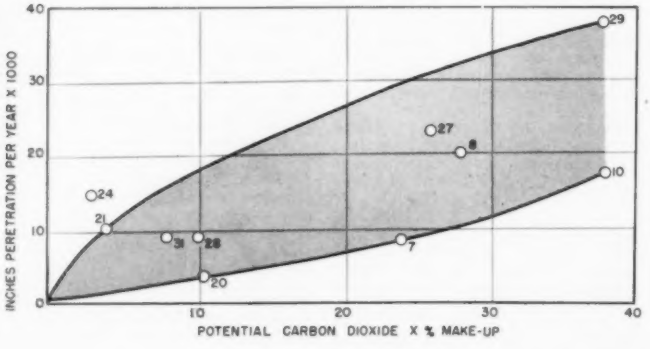


Fig. 3. Curve shows relation of potential carbon dioxide in steam to the rate of return condensate. Numbers are state plants referred to in tables

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the heater that it failed to open to discharge non-condensable gases. Relocation of this thermostatic valve to a cooler area or substitution of a throttling valve has relieved these conditions of air binding. In cases where elevation of the feedwater heater was only a few feet above the boiler feed pumps, maintenance of temperature at approximately 208 F and closer supervision of this temperature has been requested. While sodium sulfite has been applied to supplement the removal of oxygen, efficient feedwater heater operation is necessary to avoid excessive application of this chemical which would increase cost of treatment, increase dissolved solids content of the feedwater and the resultant rate of blowdown. One of the advantages of employing sodium sulfite treatment and testing the sulfite content of boiler water is the additional "check" of feedwater heater operation provided.

Corrosion of return condensate lines from the reaction of carbonic acid on the pipe metal is often a serious problem in State plants. Carbonic acid is derived from the breakdown of bicarbonate and carbonate alkalinity of the make-up water in the boiler. In order to reduce this type of corrosion, the use of feedwaters of minimum bicarbonate and carbonate alkalinity is prescribed, as indicated in Tables III and IV. Lime-soda ash softening or the use of hydrogen exchange has been advocated for power plants employing high M alkalinity make-up waters whenever extensive rehabilitation is planned. Neutralizing and filming amine type treatments are also given consideration. When a power plant is to be rehabilitated, close cooperation is maintained with the Division of Architecture and Engineering in designing the water treatment facilities.

For an immediate improvement in condensate corrosion prevention, it is recommended that make-up water usage be kept at a minimum by maintaining a tight condensate return system and by recovering all condensate. It is recommended that the condensate system be composed of lines and traps of sufficient size and proper drainage, that condensate pumps be of sufficient capacity to return condensate rapidly to vented tanks, and that condensate holding tanks be of sufficient size and properly vented. It has been found that systems providing rapid return of condensate to vented tanks are much

(*Continued on page 108*)

Table III. Data on 18 Illinois State power plants which use the coagulation method of internal treatment

Plant	Steam Pressure	1000 lb Steam per 24 hr	Per cent Make-up	Raw Water Analysis (Parts per Million) H	M	DS	Treatment External	Internal
1*	100	425	40	245	288	548	None	O, C, PB, S
2*	140	800	40	230	130	310	None	O, C, PB, S
3*	105	800	25 (E)	350	260	1137	None	O, C, PB, S
4*	120	375	27	293	336	354	None	O, C, PB, S
5 (a)	125	170	24	80	23	120	None	O, C, PB, S
6 (a)	105	300	56	80	23	120	None	O, C, PB, S
7* (a)	100	110	30 (E)	128	100	147	None	O, C, PB, S, N
8*	110	1300	13	294	290	328	BSE	P, PB, S, N
10*	125	1200	29	244	264	482	BSE	O, S
11*	5	25	15 (E)	244	264	482	SE	O, S, N
12*	125	250	47	117	420	578	None	O, S, N
13	100	50	20 (E)	95	67	220	None	DB
14	100	100	50 (E)	68	16	126	CLS	DB, S
15*	1–60 psig; 14–5 psig.	300 (E)	20 (E)	308	280	1197	BSE	DB, S
16*	1–100 psig, 2–15 psig.	80	10 (E)	128	100	147	None	DB, S
17*	4	22	5 (E)	128	100	147	None	DB, S
18*	80	28	10 (E)	128	100	147	None	DB, S
19*	1–100 psig, 6–3 psig.	100	10 (E)	289	288	319	BSE	DB, S, N

* No external de-alkalizing treatment or amine treatment has been provided in these plants employing make-up of high alkalinity content for the following reasons:

Plant 1 — Condensate line replacements are not encountered. Installation of N.D.H.A. testers is planned.
Plant 2 — Reciprocating engines are employed, and apparently oil contamination is protecting return condensate lines from corrosion, as condensate line replacements are not encountered.
Plant 3, 4 — Installation of hot-process lime-soda softeners is planned.
Plant 7, 10 — Application of filming amine is being considered.
Plant 8, 13 — Installation of hydrogen exchangers is planned.
Plant 11, 15, 16, 17, 18, 19 — In these small sized heating plants, the percentage of make-up water employed is usually low. Under these conditions, corrosion of return lines is usually not troublesome.
(E) Estimated.
(a) While these plants employ feedwater below 60 ppm hardness content and would therefore appear to require phosphate residual type treatment as indicated in Table II, actually coagulation type treatment is employed either to take advantage of deconcentrators existing in these plants or to simplify the testing and control. The caustic soda to phosphate blend ratio must be changed occasionally as the calcium and magnesium content of the raw water changes. This adjustment provides proper alkalinity and prevents the formation of magnesium phosphate sludge, which may produce an adherent type of deposit.

In Tables III and IV, the following abbreviations are employed: A — Neutralizing amine; AA — Filming amine; BSE — Blended raw and sodium exchanger treated water; C — Caustic soda; CLS — Cold process lime and soda ash treatment; DB — Domestic boiler blend; HLS — Hot process lime and soda ash treatment; N — Sodium nitrate; O — Organic blend; PB — Phosphate blend; P — Disodium phosphate; S — Sodium sulfite; SE — Sodium exchange treatment; SEA — Sodium exchange treatment following by sulfuric acid treatment and decarbonation.

Table IV. Data on 21 Illinois State power plants using phosphate residual method of internal treatment

Plant	Steam Pressure	1000 lb Steam per 24 hr	Per cent Make-up	Raw Water Analysis (Parts per Million) H	M	DS	Treatment External	Internal
20	120	320	26	117	46	168	SE	O, P, S
21	125	600	22	110	20	170	SE	O, P, S
22	250 (S)	1000	15	80	23	120	SE	O, P, S
23	250 (S)	1300	19	90	28	220	SE	O, P, S
24	125	2200	20 (E)	90	28	220	SE	O, P, S
25*	90	90	13	340	248	416	SE	O, P, S, N
26*	100	280	21	465	332	540	SE	O, P, S, N
27*	100	600	11	278	220	340	SE	O, P, S, N
28	120	250	8	248	176	274	SE	O, P, S, A
29	110	750	21	279	228	1399	SE	O, P, S, AA
30	95	280	27	270	312	319	SEA	O, P, S
31	138	1450	25	340	248	416	SEA	O, P, S
32	250	1100	11	278	220	340	SEA	O, P, S
33	250	500	45	290	205	355	HLS	O, P, S
34	135	1000	27	128	100	147	HLS	O, P, S
35	140	300	35	510	384	588	HLS	O, P, S
36	250 (S)	900	17	485	304	624	HLS	O, P, S
37	160	900 (E)	20 (E)	457	400	514	CLS	O, C, P, S
38	150	270	13	92	53	150	None	O, C, P, S
39	110	850	28	110	62	135	None	O, C, P, S
40	250	420	25 (E)	110	46	156	None	O, C, P, S
41	10	60	30 (E)	135	36	185	None	O, C, P, S

* No external de-alkalizing treatment or amine treatment has been provided in these plants employing make-up of high alkalinity content for the following reasons:

Plant 35 is a small plant, employing a low percentage of make-up water, so justification for much expenditure would be questioned. No excessive condensate line replacement is reported to date.
Plant 36 employs reciprocating engines and, as a result, oil contamination is apparently protecting the return condensate lines from corrosion.
Plant 37 will have a hydrogen exchanger for de-alkalizing the make-up water in the near future.
(E) Estimated
(S) 100 F. Superheat.

How Axial Thrust Is Balanced in Your Centrifugal BF Pump

By IGOR J. KARASSIK

Manager, Multi-Stage Pump Section
Centrifugal Pump Division
Worthington Corp.

Why is that Important? Because it is all tied up with the use of either double-suction or single-suction impellers, suction and discharge and stage pressures, construction of balancing devices, and whether the devices are used or not. You need to know about these to operate and maintain the pump properly

NEXT TO the problem of proper casing design,* the most important factor in the success of a multistage boiler feed pump is the selection of the most satisfactory impeller arrangement for the particular operating conditions.

While the double-suction impeller is definitely favored in single-stage centrifugal pump design, it introduces definite complications when applied to multistage pumps, and single-suction impellers are generally used for this type of pump. It is true that a single-suction impeller is subjected to an axial thrust, as in Fig. 1, acting towards the suction of the impeller and equal to the product of the net pressure generated and of the unbalanced area. Means can be provided, however, to counteract this unbalanced thrust and to achieve an axial balance equivalent to that of a double-suction impeller pump.

Furthermore, while the greater suction areas of a double-suction impeller permit the pump to operate with less net positive suction head, the average boiler feed pump is of relatively low capacity when compared to the entire range covered by modern centrifugal pumps. As a result, it is seldom necessary to use double-suction impellers for the sole purpose of reducing the net positive suction head required for a given capacity.

Shortcomings of the double-suction multistage boiler feed pump center mainly in the fact that this construction adds needless length to the pump shaft span. Additional space is required for the extra passage leading to the second inlet of each successive stage. In the case of a pump with as many as four or more stages, this increase in shaft span may become quite appreciable, to say nothing of the added casting difficulties. Furthermore, since it appears impractical to arrange the various impellers in any order other than the ascending order of the stages, it follows that the pressure acting on one of the stuffing boxes will be the discharge pressure of the next to the last stage.

As a result of these considerations, the majority of multistage boiler feed pumps are built with single-suction impellers. Two different methods are used to balance the axial thrust: a hydraulic balancing device, or arrangement of the impellers so that the axial thrust is balanced out.

*See article Know Your Centrifugal BF Pump Casings, by I. J. Karassik, POWER ENGINEERING, January, 1952.

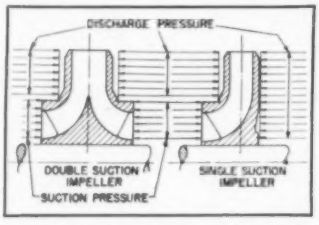


Fig. 1. Origin of axial thrust on double-suction and single-suction. Single-suction impeller is subjected to axial thrust because it exposes more back wall surface to discharge pressure than opposed front wall. This thrust must then be counteracted

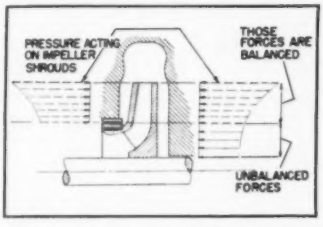


Fig. 2. Actual pressure distribution on front and back shrouds of single-suction impeller. Discharge pressure acting on two impeller walls is not uniform because liquid trapped between impeller shrouds and casing walls is in rotation. See text

Hydraulic Balancing Devices

If all the single-suction impellers of a multistage pump face in the same direction, the total axial thrust acting towards the suction end of the pump will be the sum of the individual impeller thrusts. Actually, the pressure acting on the two walls of a single-suction impeller is not uniform over the entire area exposed to the discharge pressure, as shown in Fig. 2. Therefore, the total axial thrust is somewhat less than the total pressure generated by the pump times the annular unbalanced area. A hydraulic balancing device is that part of the pump structure used to counterbalance this axial thrust.

Balancing Drum: — The balancing drum is illustrated in Fig. 3. The balancing chamber at the back of the last stage impeller is separated from the pump interior by a drum keyed or screwed to the shaft. The drum rotates with the shaft and is

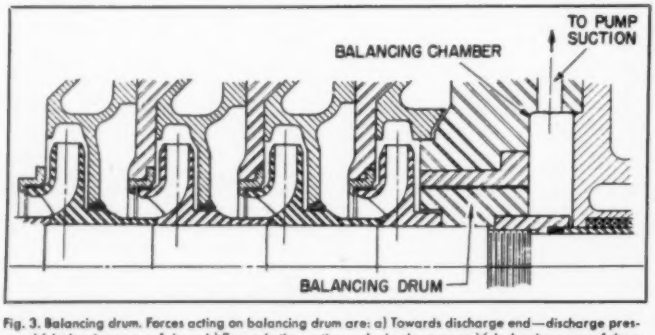


Fig. 3. Balancing drum. Forces acting on balancing drum are: a) Towards discharge end—discharge pressure × balancing area of drum. b) Towards the suction end—back pressure × balancing area of drum

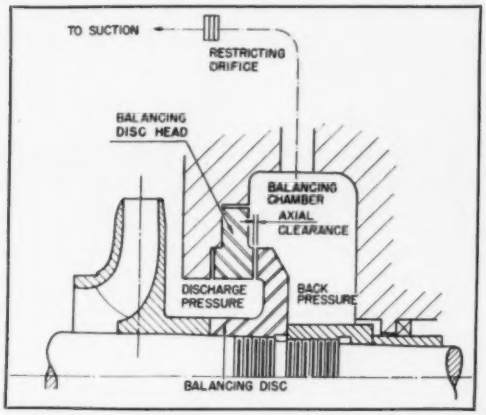


Fig. 4. Simple balancing disc. Its operation requires a restricting orifice in return line to suction. Leakage through clearance flows into balancing chamber, thence to pump suction or heater, just as in case of balancing drum

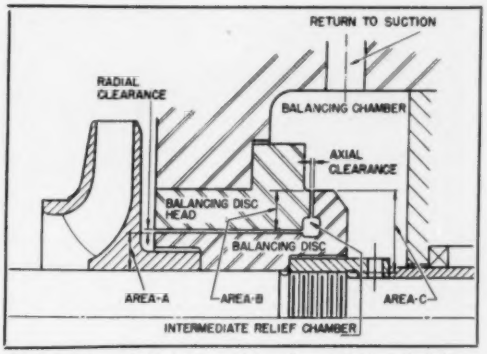


Fig. 5. Combination balancing disc and drum. Force acting towards discharge end is sum of discharge pressure times area A plus average intermediate pressure times area B. Force towards suction end is back pressure times area C

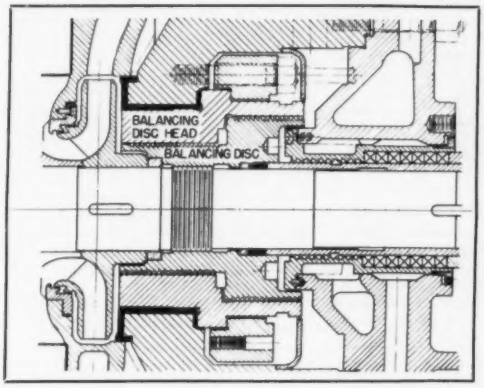


Fig. 6. Combination balancing disc and drum with disc located in center portion of drum. The relief chamber at the center provides hydraulic cushioning effect. When pump rotor moves toward suction end, pressure builds up and increases average intermediate pressure on B giving balancing force

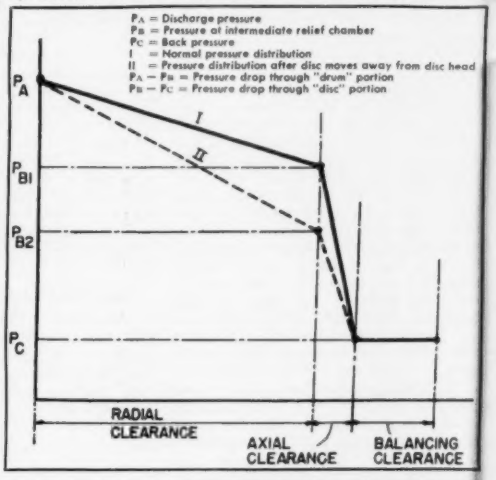


Fig. 7. Chart showing the pressure distribution in a combination balancing disc and drum. The chart is strictly schematic and qualitative. The pressure curve is not necessarily a straight line. Operation of this balancing device is based upon variations in the variation of the intermediate pressure as shown

separated by a small radial clearance from the stationary balancing drum head. The latter is fixed to the pump casing.

The balancing chamber is connected either to the pump suction or to the deaerating heater from which the pump takes its suction. The back pressure in the balancing chamber is only slightly higher than the suction pressure, the difference between the two being equal to the friction losses between this chamber and the point of return.

Net force acting on the balancing drum serves to counterbalance the axial thrust exerted on the single-suction impellers. The drum diameter can be selected so as to balance this thrust either completely or within 90 to 95 per cent depending on whether or not it is desired to carry any portion of the axial thrust on the thrust bearing.

To reduce the balancing drum leakage, it has been found desirable to provide a series of steps along the drum and interpose small relief chambers at each step. In addition, the drum surface may be serrated. Such a construction has been found to give longer life than the straight piston type drum.

Balancing Disc: — The balancing drum lacks the virtue of automatically compensating for any changes in axial thrust imposed by the impellers. Should the axial thrust become unequal to the force acting upon the balancing drum, the rotating element will tend to move in whatever direction the excessive force is acting and the thrust bearing must intervene to prevent excessive motion of the rotating element. Operation of the simple balancing disc is illustrated in Fig. 4. The disc, mounted on the shaft, is separated from the balancing disc head by a small axial clearance. The leakage through this clearance flows into the balancing chamber and thence to the pump suction or deaerating heater, just as in the case of the balancing drum. The back of the balancing disc is subject to the back pressure in the balancing chamber, while the face of the disc is acted upon by an intermediate pressure, which is equal to the discharge pressure at the smallest diameter of the disc and to the back pressure at its periphery. The inner and outer diameters of the disc are so chosen that the difference between the total force acting on the disc face and that acting on its back balance the axial thrust on the impellers.

If at any time the axial thrust exceeds the force acting on the disc, the latter is moved towards the disc head, reducing the axial clearance and, therefore, the leakage. As a result, the friction losses in the return line are also reduced, lowering the back pressure in the balancing cham-

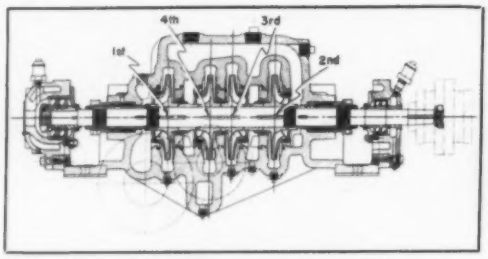


Fig. 8. (Above) Section of a four-stage, "opposed-impeller" boiler feed pump

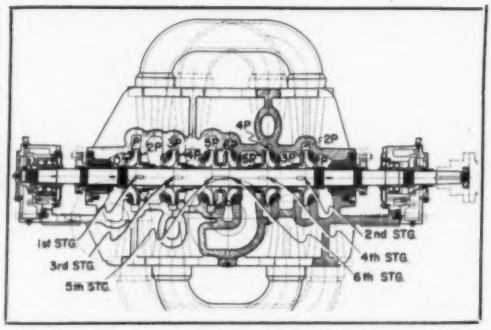


Fig. 9. Section of a six-stage "opposed-impeller" boiler feed pump. It is assumed suction pressure is 0_1 pressure generated by each impeller is "P"

ber. This increases the pressure difference acting on the disc and moves it away from the disc head. The clearance is thus increased until an equilibrium is reached, when the thrust forces balance in both directions.

To assure this sequence of events, the variation in back pressure that takes place in the balancing chamber must be of an appreciable magnitude. Thus, with the balancing disc in its wide open position with respect to the disc head, the back pressure must be substantially in excess of the suction pressure in order that the reduction of the force acting on the disc towards the discharge end may be sufficient to restore the disc and the rotating element to their normal position. This can be accomplished by locating a restricting orifice in the return line to the suction which acts to build up the back pressure, if the leakage past the disc increases beyond normal. The disadvantage of this requirement is that the pressure on the stuffing box is variable — a condition to be avoided, for it is injurious to the life of the packing.

Combination Disc and Drum: — The combination balancing disc and drum (see Fig. 5) was developed to obviate this shortcoming of the simple disc. The rotating portion of the balancing device consists of a long cylindrical body, which rotates within the drum portion of the disc head, followed by a disc similar to the one previously described. The radial clearance is always constant, while the axial clearance varies with the axial position of the pump rotor. The force acting towards the discharge end is made up of the sum of the discharge pressure times area A plus the average intermediate pressure times area B, while the force acting towards the suction end is the back pressure times area C.

The "position-restoring" feature of the combination disc and drum is achieved by a variation in the intermediate pressure instead of a wide variation in back pressure. When the pump rotor moves towards the suction end because of an increased axial thrust, the axial clearance is reduced and pressure builds up in the intermediate relief chamber, increasing the average intermediate pressure acting on area B. See Fig. 7.

Modifications: — Obviously, numerous modifications of the principles are embodied in the design of hydraulic balancing devices. One typical modification consists of separating the drum portion of a combination device into two halves, of which one precedes and the second follows the disc itself, as shown in Fig. 7. This provides a cushioning effect at the intermediate relief chamber, thus avoiding the possibility of too positive a restoring action which might result in contacting the disc faces and scoring them.

Opposed Impeller Balancing

The greater the pressure differential across a breakdown or leakage joint inside the pump, such as a balancing device, the greater will be the wear on this joint. This disadvantage has led to the desire of obtaining axial balance of multistage pumps by means other than use of a hydraulic balancing device. This can be accomplished by using an even number of stages, half of the single-suction impellers being mounted in the opposite direction to the other half so that the axial thrusts on the two groups of impellers balance each other. This mounting of single suction impellers back to back is frequently referred to as "opposed impellers."

Figures 8 and 9 illustrate the principle of axial balance through opposed impellers as applied to typical four-and six-stage pumps. Instead of one pressure-breakdown under full pump differential pressure, several joints between adjacent stages are subjected to a lower differential pressure, the exact value of the latter depending upon the specific stage arrangement used.

The foregoing should not lead to

(*Continued on page 107*)

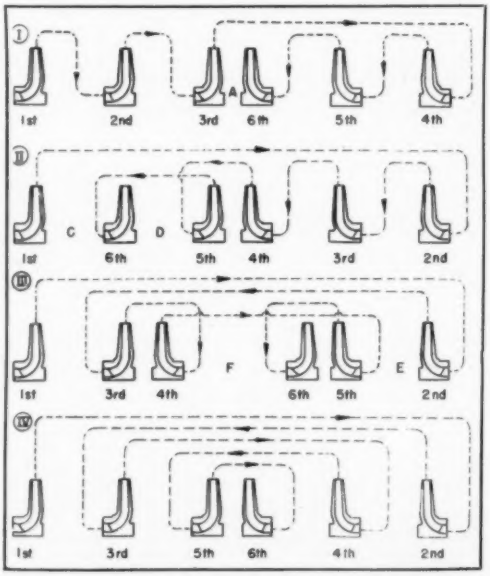


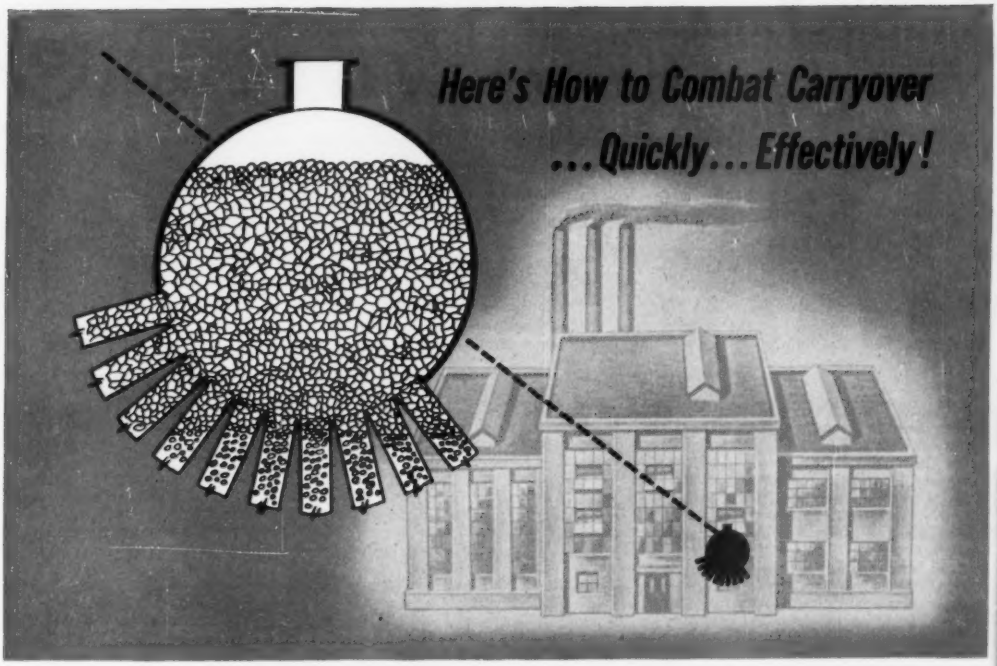
Fig. 10. Various stage arrangements for a six-stage axially balanced pump:

I. Joint A is subject to a 3-stage pressure differential. One stuffing box is under high pressure at B

II. There are two high pressure joints: a 4-stage pressure differential at C and a 2-stage pressure differential at D

III. Joints E and F are under a 2-stage pressure differential

IV. All running joints are subject to only 1-stage pressure differential, as shown



One of the most common sources of trouble and expense in steam power systems is carryover and excessive blowdown. But these troublesome conditions, even when extreme, can easily be overcome by the proper application of anti-foam agents.

To illustrate the point, in one plant operating with 100% cold lime soda softened make-up water, boiler water concentrations above 7,500 ppm caused severe carryover with normal boiler water levels. With water level two inches above normal, carryover occurred at 6,500 ppm boiler water solids. It was necessary that boiler water concentrations be restricted by the maintenance of a 16 to 20% rate of blowdown.

Application of anti-foam agents to this problem permitted doubling the boiler water concentrations and reduced blowdown to the range of 8-10%. In addition, heat savings in blowdown totaled more than $30.00 per day!

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Simple Figuring for Minor Feed Heating Cycle Changes

You use only arithmetical computation and a heat balance diagram. Here are the simple methods by which you can figure how minor variations will affect the cycle, after you have fixed the turbine conditions. Variations include terminal difference, extraction-line pressure drop use of evaporator

By W. F. ALLEN, Jr.
Mechanical Engineer
Mechanical Division
Stone & Webster Engineering Corp.

THE STEAM POWER PLANT engineer is concerned with minor variations in the feed heating cycle after the turbine size, steam conditions and location of extraction openings have been specified. Significant minor variations include terminal difference, which fixes the amount of feedwater heater surface to be purchased, extraction-line pressure drop, which fixes extraction pipe size, cascading versus pumping heater drains, use and location of an evaporator in the feed cycle compared with treated make-up, and possible use of an evaporator condenser.

Difference Method is Accurate: — Change in heat rate due to minor variations in the feed cycle can be obtained by a difference method in perhaps 10 per cent of the time or less, and to equal or greater accuracy, than by conventional heat-balance methods. A difference method is simple and easy to follow because, in most cases, the effect of variations can be computed using only a heat balance for a basic scheme, without recourse to turbine performance data. A difference method is based on considering the changes in mass flows and enthalpies due to the imposed minor variations in cycle conditions rather than total quantities.

Herewith is a conventional heat balance diagram for a 60,000-kw preferred-standard turbine generator, 850 psig, 900 F, with five heaters. In Table I are listed the changes in heat rate obtained by the difference method that result from individually increasing terminal difference at each closed heater from 5 F to 7 F and individually eliminating the approximate 5 per cent pressure drop in each extraction line.

Solution for Effect of Variation in Terminal Difference by a Difference Method: — The difference method calculations are simplified if the condenser flow is fixed. This makes it possible to consider the heat rejected as a constant and by determining the change in total extraction flow, the change in heat supplied in the steam generator and change in heat rate may be readily evaluated. The variation in stage pressures with moderate changes in extraction flows may be neglected,* and consequently all enthalpies may be fixed at the original values except those at the heater under investigation.

If the terminal difference at the top heater is increased by 2 F to 7 F with the condenser flow fixed, the principal effect will be a reduction in the extraction steam flow to the top heater. A secondary effect will be an increase in the extraction steam flows to the three heaters immediately below the top due to cascading a reduced quantity of heater drips. A preliminary estimate of the reduc-

*Evaluation of the Effect of Terminal Difference and Pressure Drop on Steam Power Plant Heat Rate, by W. F. Allen, Jr. *ASME Fall Meeting Paper No. 51-F-28.*

Table I. Change in turbine heat rate, Btu per kwh, from heat balance on accompanying diagram for 60,000-kw, 850-psig, 900-F turbine generator

	Heater No.	Difference
Increase of terminal difference from 5 F to 7 F (All values are plus)	1	3.3
	2	2.6
	3	3.0
	5	2.1
Elimination of 5% pressure drop in extraction piping (All values are minus)	1	7.2
	2	4.4
	3	4.3
	4	3.2
	5	2.5

Table II. Calculations to show the effect of elimination of extraction line pressure drop for heater No. 1 in feed heating cycle on heat balance diagram

Condensate enthalpy increase at heater outlet = 5.08h

Heater No.	
1	[518,050 (5.08) + 34,060 (5.1)] ÷ (1,339 − 380.5) = 2927 lb
2	[− 2,927 (385.9 − 312.4) − 34,060 (5.1)] ÷ (1271.5 − 312.4) = − 405 lb
	Assume 2500 lb increase in drip flow to heaters Nos. 3 and 4
4	− 2500 (250.7 − 201.2) ÷ (1140.8 − 201.2) = − 132 lb
3	[2500 (317.7 − 245.6) + 132 (1140.8 − 245.6)] ÷ (1197.8 − 245.6) = − 65 lb
2	[− 2927 (385.9 − 312.4) − 34,060 (5.1) + 132 (1140.8 − 312.4) + 65 (1197.8 − 312.4)] ÷ (1271.5 − 312.4) = − 231 lb
1	[518,050 (5.08) + 132 (1140.8 − 380.5) + 65 (1197.8 − 380.5) + 231 (1271.5 − 380.5)] ÷ (1339 − 380.5) = 3120.5 lb*
	Recompute with revised drip flows
4	− (2824 − 2500) (250.7 − 201.2) ÷ (1140.8 − 201.2) = − 17 lb
3	[− (2889 − 2500) (317.7 − 245.6) + 17 (1140.8 − 245.6)] ÷ (1197.8 − 245.6) = − 13 lb
2	[− (3120.5 − 2927) (385.9 − 312.4) + 17 (1140.8 − 312.4) + 13 (1197.8 − 312.4)] ÷ (1271.5 − 312.4) = 12 lb
1	[17 (1140.8 − 380.5) + 13 (1197.8 − 380.5) − 12 (1271.5 − 380.5)] ÷ (1339 − 380.5) = 13.4 lb*
	Change in extraction flow = 3134 − 219 − 78 − 149 = 2688 lb

$$\text{Revised heat rate} = \frac{(518{,}050 + 2688)(1453.1 - 380.48)}{60{,}000 + \{[2688\,(1453.1 - 380.5) - 518{,}050\,(5.08)] \div 3412.75\}}$$

= 9297.82 Btu per kwh

* Reported to 0.1 lb in order to obtain change in extraction flow to nearest pound because recomputation involves a second set of differences superimposed on first set.

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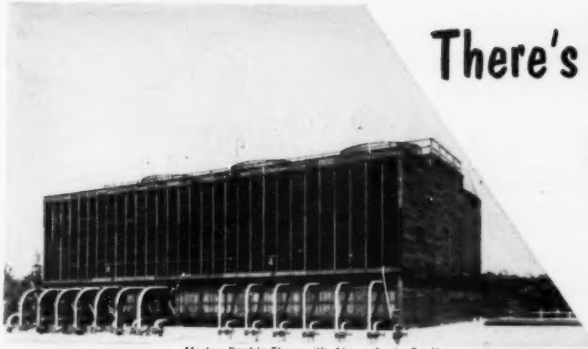

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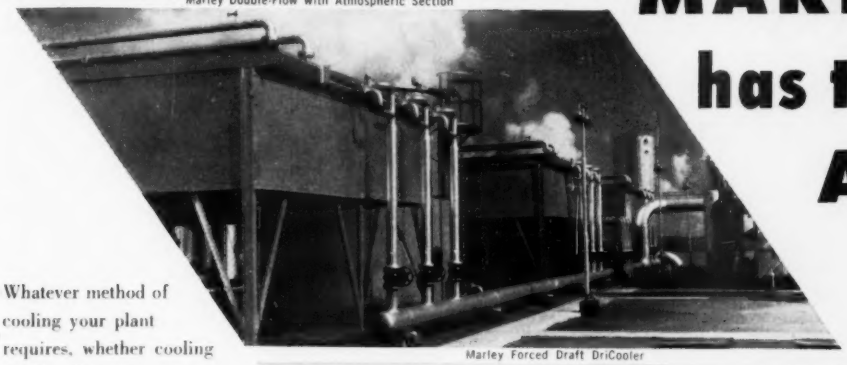

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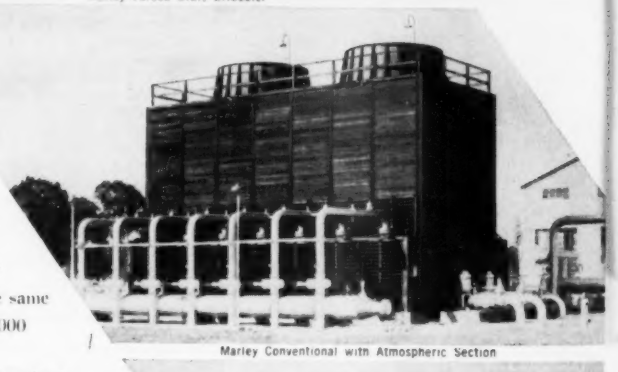

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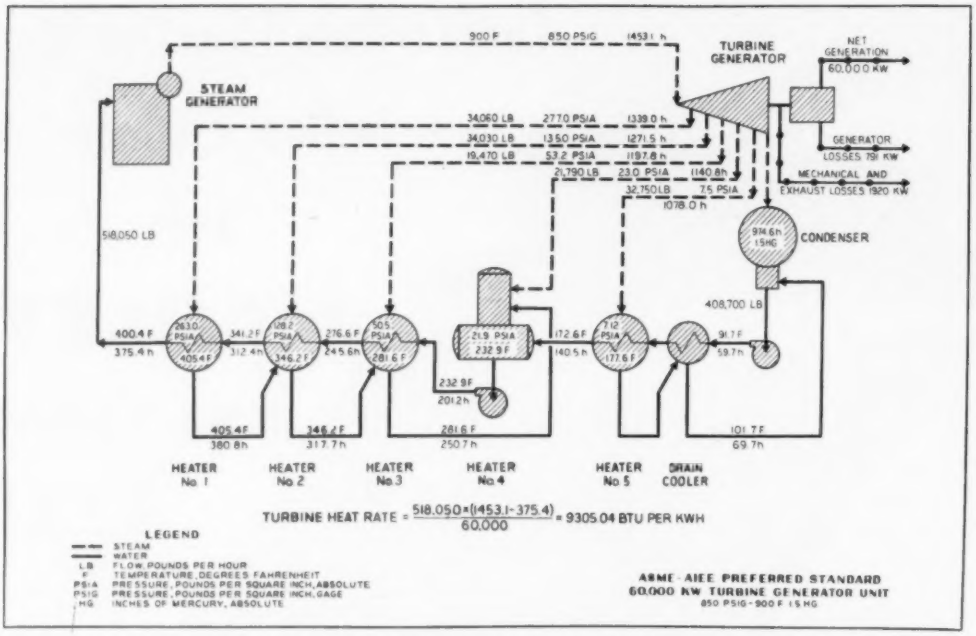

Heat balance diagram for one 60,000-kw, 850-psig, 900-F, 1.5 Hg ASME–AIEE preferred standard turbine generator unit, for which calculations are given

tion in extraction flow to the top heater using 2.17h as the enthalpy change corresponding to 2 F is as follows:

$$518{,}050\ (-2.17) \div (1339 - 373.2) = -1{,}164\ \text{lb}$$

The term lb = pounds per hour throughout this article.

The dividend represents a preliminary estimate of the total reduction in heat supplied from the top extraction stage to the complete condensate system above the enthalpy datum of 373.23h which is the new condition at the feedwater outlet of the top heater. (The value 373.2h may be used as the datum for all other mass flow terms without affecting accuracy; h representing Btu per lb.

The dividend is not the actual reduction in heat supplied by extraction steam to the complete condensate system above the enthalpy datum because of changes in drip flows to the lower heaters. The divisor represents the heat supplied to the condensate system per pound of top stage extraction steam above the enthalpy datum of 373.2h.

Change in Drip Flow: — The next step in the procedure is to assume a change in drip flow to the lower heaters. Guided by the preliminary estimate of the reduction in extraction flow to the top heater, and the consideration that a decrease in drip flow to the lower heaters will cause increases in extraction flows to lower heaters, it is assumed that the reduction in drip flow to the lower heaters is an even 1200 lb. This is not a critical assumption. The knowledge that the increase in lower stage extraction flows will result in an additional decrease in top heater extraction flow is utilized only to predict that the reduction in drip flow will be nearer 1200 lb than 1100 lb.

Then considering a combined system consisting of the 4th and 5th point low-pressure heaters, the increase in 4th point extraction steam flow due to the assumed reduction in drip flow is:

$$1200\ (250.7 - 201.2) \div (1140.8 - 201.2) = 63\ \text{lb}$$

The dividend is the reduction in heat supplied from the drip flow to the combined system consisting of 4th and 5th point heaters above the enthalpy datum of 201.2h at the 4th point heater outlet. The divisor represents the heat supplied per pound of 4th point extraction steam above

Table III. Possible set of rules for applying the difference methods, for any minor variations in cycle

Suggested Rules for Applying Difference Method

1. Consider the condenser flow constant. (This makes it possible to consider the heat rejected as constant and thus evaluate the change in heat rate by obtaining the change in total extraction steam flow.)
2. Make a preliminary estimate of the change in extraction steam flow to the heater or heaters principally affected. Use the value of enthalpy at the condensate outlet of the heater as the datum.
3. Use the preliminary estimate of changes in extraction steam flow to the heaters principally affected to estimate changes in drip flow.
4. Compute changes in extraction steam flow to each heater, commencing with the lowest heater affected and successively enlarging the system in subsequent calculations while considering the outlet condensate enthalpy of the highest heater included in the combined system as a datum enthalpy, except for a closed pumped heater as the highest heater use the drip enthalpy as the datum for its extraction flow and drip flow.
5. Cease modifying drip flow when desired accuracy is obtained.
6. Use change in total extraction steam flow to compute change in heat rate.

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easy to remove separate units

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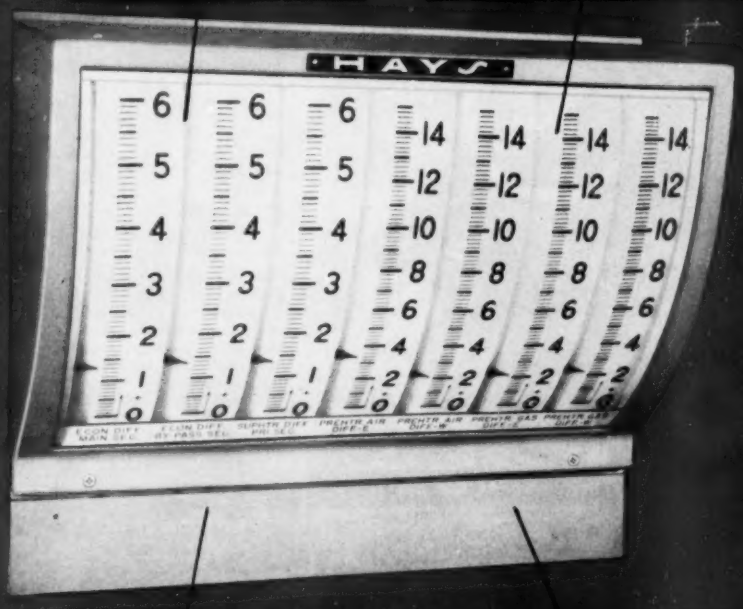

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Accessibility from the front makes possible easy "one man" method of quickly checking zero. (The fast 3-way cock with test fitting is *standard* on the Hays Vertiscale).
Simple maintenance—individual units can be quickly removed for inspection or adjustment. Removal does not affect other units in the case, does not disturb calibration of unit being re-installed.
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Yes, and because a Dart's precision ground to a perfect sphere, the tight seal comes easily and stays tight without heavy wrenching or fuss.

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the enthalpy datum of 201.2h.

Next, considering a combined system consisting of the 3rd, 4th and 5th heaters, the increase in extraction flow to the 3rd point heater may be obtained

$$[1200\ (317.7 - 245.6) - 63\ (1140.8 - 245.6)] \div (1197.8 - 245.6) = 32 \text{ lb}$$

The first mass enthalpy product of the dividend is the reduction in heat supplied from the drip flow to the combined system above the enthalpy datum of 245.6h at the 3rd point heater feedwater outlet. The second composite term in the dividend is the increase in heat supplied from the extraction flow to the 4th point heater to the combined system above the enthalpy datum.

System Including All Heaters Below Top: — In turn considering a system consisting of all heaters below the top heater, the increase in extraction flow to the 2nd point heater is

$$[1200\ (380.8 - 312.4) - 63\ (1140.8 - 312.4) - 32\ (1197.8 - 312.4)] \div (1271.5 - 312.4) = 2 \text{ lb}$$

The first product in the dividend, as before, is the reduction in heat supplied from the drip flow to the new combined system, and the second and third products represent the increase in heat supplied from lower stage extraction steam flows, all above the enthalpy datum of 312.4h at the 2nd point heater outlet.

Entire Feedwater System: — Finally considering the entire feedwater system, the reduction in extraction steam flow to the top heater is obtained as

$$[518{,}050\ (-2.17) - 63\ (1140.8 - 373.2) - 32\ (1197.8 - 373.2) - 2\ (1271.5 - 373.2)] \div (1339 - 373.2) = -1243 \text{ lb}$$

The first product in the dividend represents the decrease in heat required from the top extraction stage to the entire condensate system exclusive of the effect of increased lower stage extraction flows. Subsequent products in the dividend represent the increase in heat supplied from lower stage extraction steam flows to the entire system above the enthalpy datum of 373.2h.

The change in total extraction flow is

$$-1243 + 2 + 32 + 63 = -1146 \text{ lb}$$

Change in heat supplied in the steam generator is:

$$-1146\ (1453.1 - 373.2) + \frac{518{,}050}{(2.17)}$$

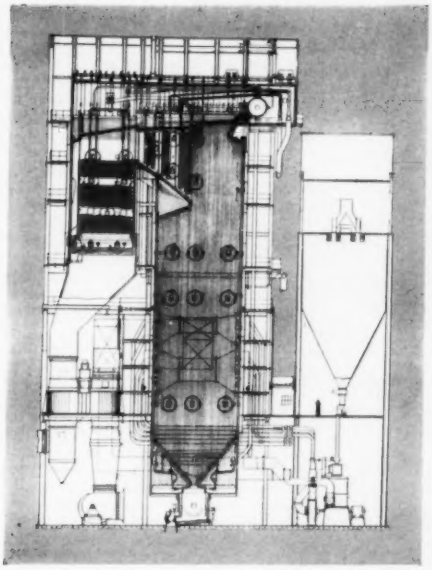
Change in kilowatt output is the change in heat supplied divided by 3412.75 and is represented by N.

The revised heat rate is

$$\frac{(518{,}050 - 1146)\ (1453.1) - 373.23)}{60{,}000 + N} = 9308.31 \text{ Btu per kwh}$$

(Continued on page 104)

it's **VULCAN** for Electric Energy, Inc.



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Steam Generators ..... **4 Radiant-Reheat Type; Combustion Engineering-Superheater, Inc.**

Capacity, each ..... **1,200,000 lb per hr**

Throttle Pressure ..... **1800 psig**

Primary Steam Temperature ..... **1050 F**

Reheat to ..... **1000 F**

Fired by ..... **Pulverized Coal**

Soot Blowing ..... **Vulcan Automatic Sequential System includes wall blowers, long retracts for superheater and reheater sections, rotaries for economizer and air heater-cleaner controls; driven by air. Blowing medium—air.**

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Each of the four combustion steam generators ranks with the largest ever built. At full capacity the four may burn as much as 7,500 tons of coal every 24 hours. High boiler availability will be at a premium, for Joppa Station will play a major role in our national defense program.

Vulcan offers effective cleaning, with minimum maintenance—for large boilers or small—utility or industrial—power or process. A letter will bring you facts on how Vulcan can save for you.

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Fig. 4001/6561. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Angle Blowing Valve.

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When you install an EVERLASTING Duplex Blow-Off Unit, you'll find that its many superiorities speak for themselves.

The sealing valve at the left is the EVERLASTING design that has been famous for more than 40 years . . . the valve with the drop-tight seal that actually improves with use because of its self-lapping action each time the valve is opened or closed . . . the valve that can't stick or jam because of its non-wedge design . . . the valve that opens in less than a quarter turn to provide unimpeded straight-through blow.

The blowing valve at the right is the equally famous EVERLASTING Angle or "Y" Valve, specially designed and equipped to withstand repeated blow-off shocks, erosion and corrosion, and without pockets that might trap and hold solids.

Each of these valves . . . and all the other EVERLASTING Boiler Blow-Off Valve types, fully meet ASME code requirements . . . assurance that they are properly designed and amply strong for the service.

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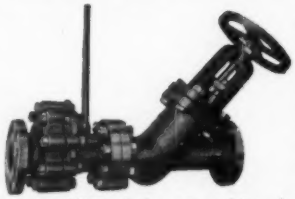

Fig. 4001/6571. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Y Blowing Valve.

Fig. 6571/6561. Duplex unit consisting of Y Sealing Valve and Angle Blowing Valve.

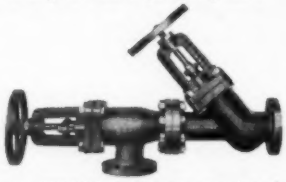

Fig. 6561/6571. Duplex unit consisting of Angle Sealing Valve and Y Blowing Valve.

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Solution for Effect of Variation in Pressure Drop by a Difference Method: — A difference method calculation for the effect of pressure drop in the 1st point heater extraction line is shown in Table II.

Accuracy of Difference Method Results: — The terminal difference heat rate results have been computed to an accuracy of ± 0.1 Btu per kwh and pressure drop heat rate results have been computed to an accuracy of ± 0.2 Btu per kwh. For use in design, in many cases the precision requirements may be relaxed.

The unit investigated requires approximately a 3-lb change in total extraction steam flow to create 0.1-Btu-per-kwh change in heat rate. This figure will differ slightly for other units but may be easily ascertained in individual cases. Clearly the stated limits of accuracy are not infringed on if the change in total extraction steam flow is reported to the nearest pound per hour.

In the heater No. 1 terminal difference analysis, it was unnecessary to extend the calculation for further modifications in drip flow as it requires approximately 15-lb change in drip flow to cause a 1-lb change in the individual extraction steam flow and an individual heater must be several pounds per hour out of balance to result in a 1-lb change in total extraction steam flow. For example, the extraction steam flow to the No. 2 heater may be 3 lb too high, with the only effect being that the steam flow to the No. 1 heater is too low by 3 lb.

Difference Method Sensitivity: — The difference method results are not particularly sensitive to the accuracy of the original heat balance. The heat rate in the heat balance diagram is reported to six figures solely in order that it will be numerically consistent with the original value of heat supplied, used in conjunction with the change in heat supplied obtained by the difference method to find a new heat rate. A satisfactory alternative procedure would be to report the original heat rate to four figures and use the heat rate kilowatt output product as the original value of heat supplied.

The effect on stage pressure of a change in flow to the following stage has been neglected in all cases, not because it is impossible to consider changes in stage pressure with a difference method, but rather because it is unnecessary in most cases when considering minor variations.

The assumption of constant heat rejection from the turbine exhaust is based on a constant turbine internal efficiency for small changes in throttle flow. The heat rate changes listed in Table 1 are based also on the assumption that the heat rate for any given cycle is the same at 60,000 kw as four outputs varying from 33 kw less to 73 kw greater than 60,000 kw.

Outline of Procedure: — A possible set of rules for applying the difference method to solve for any minor

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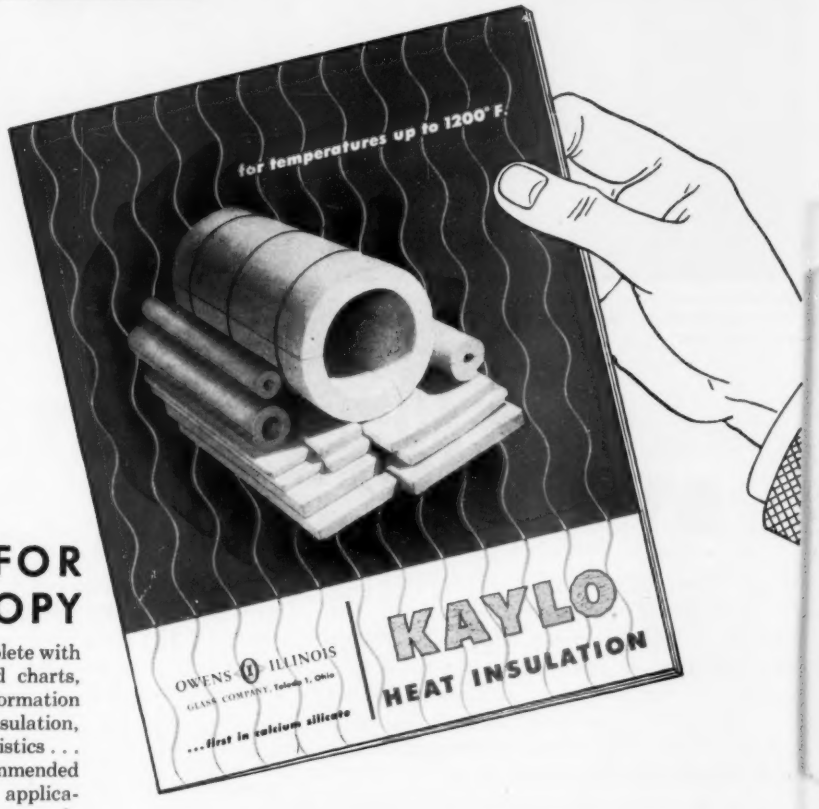

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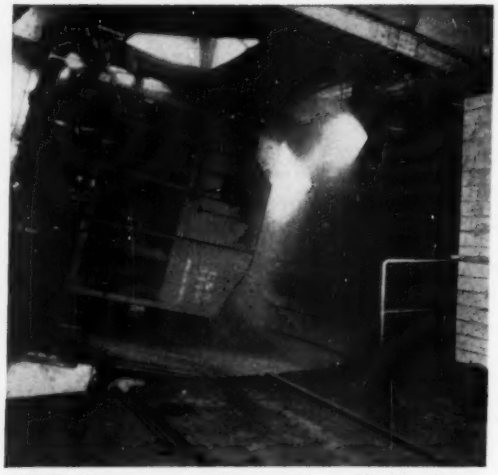
BEFORE—Johnson-March system turned off at car dumper of a large midwest utility. Compare this unretouched photo with the one at the right.



AFTER—Note absence of dust when Johnson-March system is operating at this same dumper. These systems have proved themselves in many plants. We'll be glad to furnish names.

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variation in cycle conditions is shown in Table III:

The rules listed in Table III and the calculations included in the paper are not intended to serve as a rigid and inflexible outline of difference method procedure but rather as a guide and explanation of possible procedure. In fact, it may be advantageous to carry out difference method computations in some cases, notably for reheat units, with a variable condenser flow and some other fixed flow.

CENTRIFUGAL BF PUMP

(Continued from page 96)

the erroneous conclusion that a hydraulic balancing device is symbolic of a design either obsolete or inferior to others. When boiler feed pump pressures exceed certain limits, it becomes necessary to use a radially-split casing. This type of casing does not lend itself readily to any arrangement except one where all the impellers face in one direction and follow in the ascending order of the pump stages. As a result, the hydraulic balancing device is the proper and only logical method of eliminating the axial thrust and of reducing the pressure on the discharge side stuffing box. An axially-split casing pump, on the other hand, permits the arrangement of stages so that one half of the impellers face the other half, and in the range of pressures suitable to axially-split casings, the hydraulic balancing device can be eliminated.

Arrangement of Stages

Once a multistage pump is balanced through the use of opposed impellers, it remains to determine the most satisfactory sequence in which the individual stages are to be arranged within the pump casing. Three separate factors enter into the analysis of a satisfactory stage analysis and the final solution must be a compromise between the individual solutions which satisfy the following requirements:

(1) The arrangement of the stages should result in the minimum possible leakage at the running joints. This means that the pressure difference between any two adjoining stage chambers should be kept to the minimum possible and several low pressure running joints are preferable to a fewer number of joints subject to a higher pressure.

(2) The impellers should be so arranged that the stuffing boxes will be subjected to the lowest pressures within the pump.

(3) The sequence of the stages should be such as to avoid excessive complications in the forming of the interstage passages.

That the problem is not simple may be illustrated by the analysis of the best arrangement to be used for a six-stage pump. It can be shown by the use of the permutation formula

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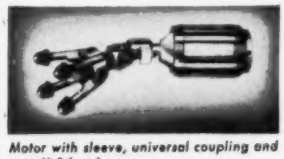
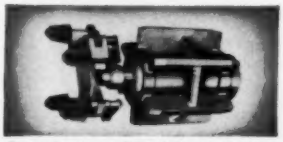


Motor with sleeve, universal coupling and type H-2 head.



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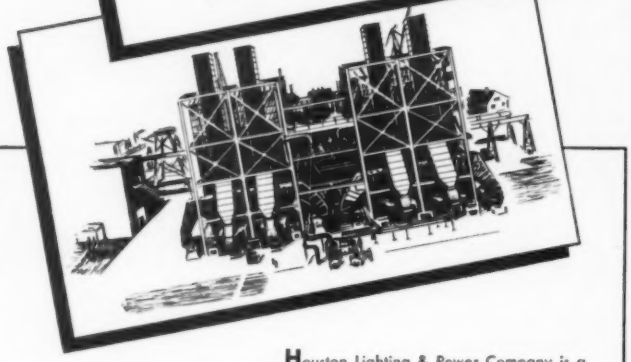

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that 720 arrangements can be used for a sequence of six impellers. Of these, half are duplicates, since they describe the same arrangement as viewed in a mirror. The problem is simplified by the fact that the majority of the potential sequences are rather complicated and can be eliminated entirely. Figure 10 illustrates four of the most logical possibilities that can be used for a six-stage pump.

Effects of Arrangements

It will be seen that Arrangements I, II and III have greater pressure differentials at the running joints than Arrangement IV. The latter is superior by the fact that the pressure differences between any two adjoining stage chambers do not exceed the pressure generated by a single stage. This fact is shown by Fig. 9, which shows a six-stage pump built in accordance with this arrangement.

Concerning the effect of the stage sequence selected upon the stuffing-box pressures, except for Arrangement I, all the sequences illustrated in Fig. 10 are satisfactory because, by placing the two lowest-pressure-stage impellers at the two ends of the casing, the stuffing-box packing will be relieved of the high pressures and subjected to the lowest pressures within the pump; namely, the suction and the first-stage discharge pressures.

It is true that the third condition, which deals with the simplicity of the interstage passages, is not easily compatible with the first two. Its importance, however, is secondary and it should not assume precedence over the desirability of reducing interstage pressure differences. In certain cases, of course, when the individual stage pressures are relatively low, a compromise may be most satisfactory. For instance, if a pump should be designed with a stage pressure of not over 125 to 150 psi, it would be permissible to use a sequence of stages that imposes a maximum of two-stage pressure differential (250 to 300 psi) at the running joints, if this sequence leads to an appreciable simplification of the interstage connections and to a more economical pump construction. This, Arrangement III, might prove to be the most economical arrangement for medium- and low-stage pressures. However, the improvements in interstage connections of Arrangements I and II over that of III are not great enough to sacrifice the advantages of low stuffing-box pressures and lower interstage pressures.

FEEDWATER HANDLING

(Continued from page 93)

freer of corrosion, as much of the carbon dioxide is maintained in the gaseous phase and is vented in the storage tanks. One practice in the State plants which has been discouraged is the practice of adding cooling water to the vacuum pumps to cool flash steam and provide a better

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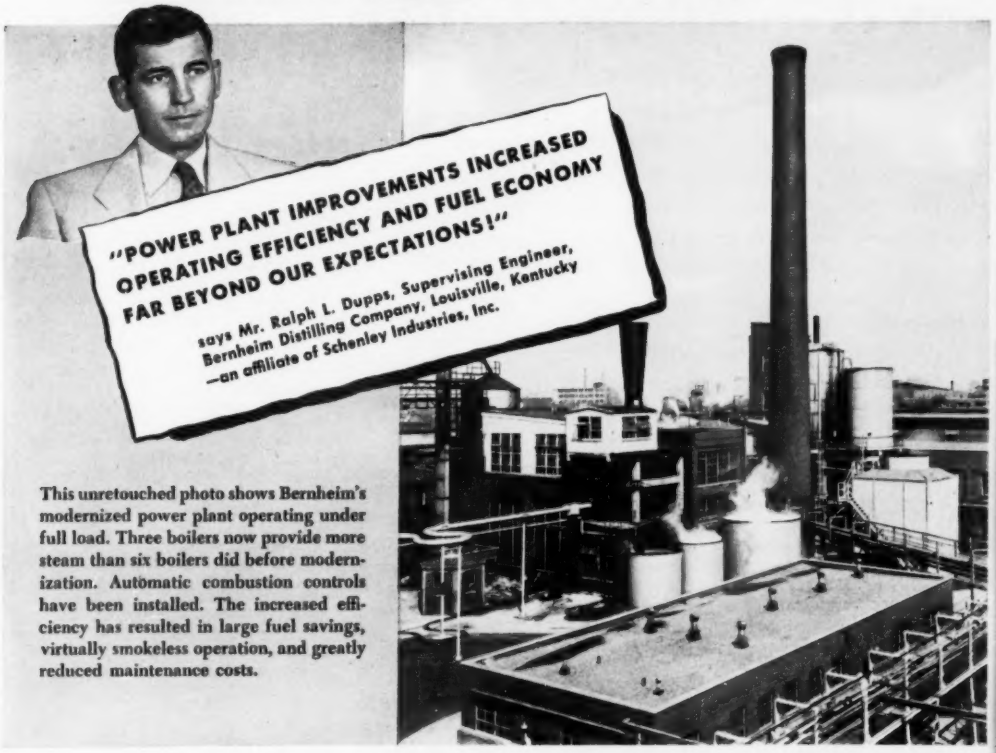
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Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

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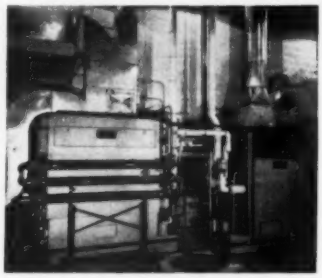

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vacuum. This practice is undesirable as excessive make-up water often is added this way and loss of valuable condensate may occur by overflow of the storage tank or feedwater heater. If cooling water is required, it has been recommended that feedwater from the feedwater heater be employed, since in this way the volume of water in the system is not increased and therefore overflow of tanks is not to be expected. Metering of make-up water is considered a "must" and an accurate account of this usage is advocated.

In plants employing reciprocating engines, oil contamination has been found to be instrumental in reducing condensate corrosion. At one State plant, the corrosion rate (inches penetration per year $\times$ 1000) was 12 in the case of condensate produced from high pressure steam, while it was only one in the case of exhaust steam containing oil. As plants containing reciprocating engines are being gradually converted to turbine equipment, corrective treatment, either in the form of external treatment of the dealkalizing type or in the form of neutralizing or filming amine, is being planned.

Plants employing acid treatment following zeolite softening are urged to use close control to provide maximum carbon dioxide removal. In one of these plants, it is planned to feed sufficient acid to neutralize all of the M alkalinity content and then to follow this treatment by caustic soda application to provide sufficient alkalinity in the feedwater heater, feed lines and boiler proper. While such a treatment method provides a high boiler blowdown rate, installation of a heat exchanger on the continuous blowdown will largely eliminate this inefficiency. There are many of the State plants which could benefit considerably in efficiency by the installation of flash tanks and heat exchangers on the continuous blowdown.

In. Fig. 3 results of NDHA type of corrosion tests conducted in return condensate lines of several of the State plants are shown. Numbers listed in Fig. 3 refer to the State plant numbers listed in Table III and IV. Potential carbon dioxide content has been calculated from the theoretical breakdown of the bicarbonate and the carbonate alkalinities in the boiler. It may be considered approximately equivalent to 0.8 $\times$ (M-P) of the feedwater. Only exception to the use of this simple formula for determining the potential carbon dioxide will be found in the case of a feedwater containing appreciable calcium bicarbonate which, by chemical treatment, is allowed to precipitate as calcium carbonate in the boiler. In this case, the bicarbonate alkalinity considered to be associated with calcium should be multiplied by a factor of 0.45 while all other alkalinity would be multiplied by a factor of 0.8, previously indicated.

Examination of Fig. 3 will disclose that a general increase in corro-

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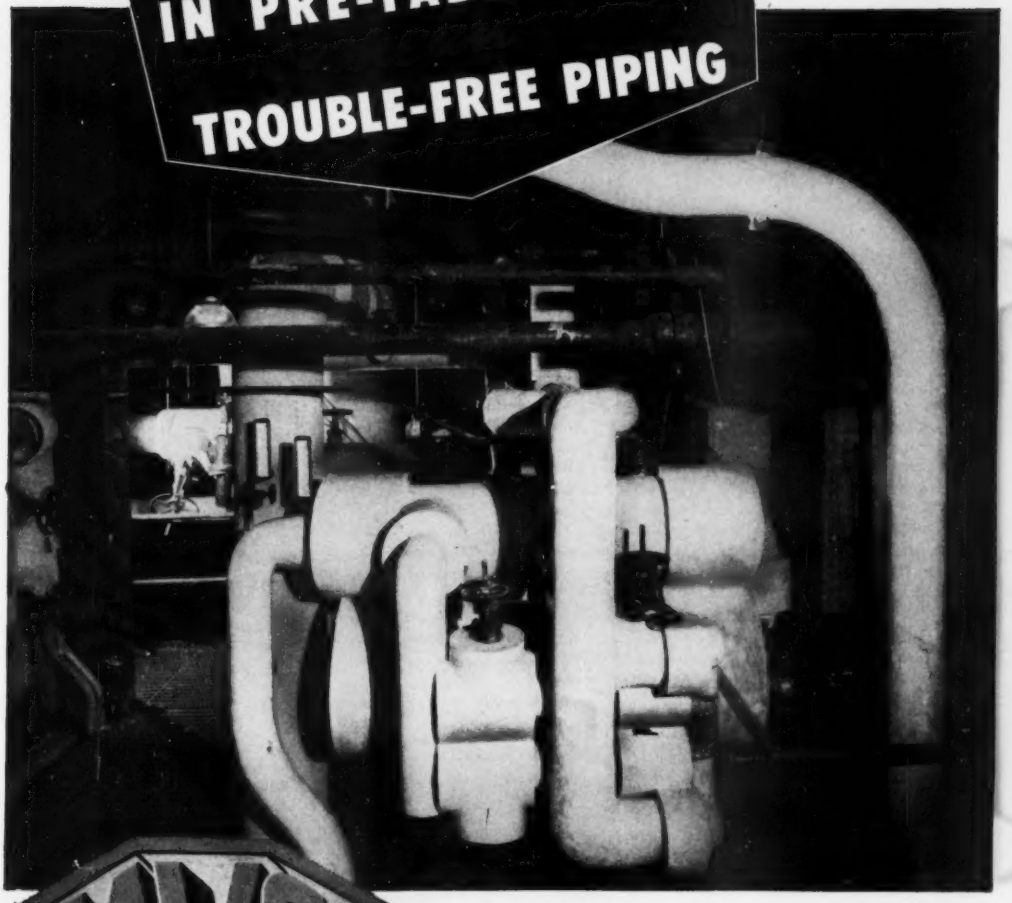

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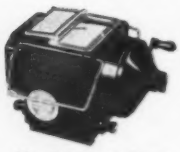
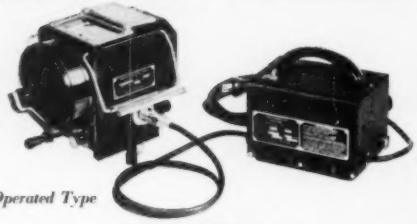
Instrument News

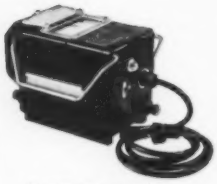


Hand-Operated Type



Dual-Operated Type

MEGGER® ELECTRICAL INSULATION TESTERS in Types to Suit Varying Needs For Shop and Field



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Available in 5 range scales from 0-300 to 0-3000 ohms. Furnished complete with test leads and reference ground rod. Dimensions of instrument are 5" x 9¼" x 6¼". Weighs about 8 lbs.

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sion rate occurs as the potential carbon dioxide content increases. At the lower levels of carbon dioxide content, corrosion is considered to be largely due to dissolved oxygen. In these cases, the determined corrosion rate appears to be higher than the actual observed plant conditions so apparently it may be assumed that the observed corrosion products are effective in preventing serious corrosion of return line piping. Quite heavy deposits of corrosion products were observed on the NDHA coils. It is believed that the corrosion rate is quite rapid when these specimens are first inserted in these lines but possibly the corrosion products become more or less protective. In future condensate corrosion tests involving dissolved oxygen type of corrosion, it is planned to place specimens for different periods of time in order to determine whether the corrosion rate decreases on further exposure. At the higher levels of potential carbon dioxide content, the disagreement in corrosion rates may be ascribed to differences in flow and rate of flow of condensate, differences in location of specimens in system, difference in condensing rate of condensate, etc.

Values above 10 in corrosion rate (IPY $\times$ 1000) are generally considered of sufficient magnitude to require corrective treatment, providing the plant is of sufficient size and has sufficient piping for justification of the expenditure.

Steam Quality

A portable steam quality tester, illustrated in Fig. 4, consisting of a modified Straub degasifier and a reccording conductivity meter has been employed in the State plants to determine economical blowdown limits, the effectiveness of competitive antifoam treatments, effect of boiler design and the effect of operating procedures on steam quality. This tester is proving to be of value in improving steam quality and for instructional purposes. In one plant, it has been instrumental in reducing the carry-over experienced during soot-blowing as the need for closer operating control and closer adjustment and maintenance of feedwater regulators was illustrated. In another plant, the need for lowering water level in order to improve steam quality was indicated.

Carry-over produced from oil con-

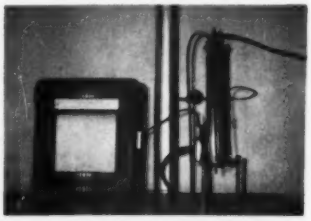

Fig. 4. Specially designed steam purity testing equipment was constructed by the Prison Industries

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tamination in another plant was eliminated by employing the partial phosphate type of treatment, by providing more exact blowdown control, by improving the efficiency of oil removal equipment, and by reducing oil usage.

Success of this program has been largely due to fine cooperation and conscientious assistance provided by each of the many plant engineers and their assistants in the State Colleges, the Department of Public Welfare, and the Department of Public Safety.

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Obituaries

ARTHUR L. ABBOTT

ARTHUR LAURIE ABBOTT, Rutherford, N. J. died on July 26 in his 80th year after a brief illness. He was a member of the staff of the National Electrical Manufacturers Association of New York, N. Y. since 1931. Mr. Abbott was previously technical director of the Electragist Association, Electrical Contractors Association. For many years he was an electrical contracting engineer in St. Paul, Minn.

Author of the National Electrical Code Handbook, and the Electrical Contractors Estimating Manual, Mr. Abbott also contributed many articles to technical publications.

Mr. Abbott was the first man to develop standards for electrical estimating which are now widely used in the electrical construction industry.

Mr. Abbott graduated in Electrical Engineering from the University of Minnesota. He was Fellow and life member of the AIEE.

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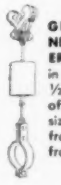

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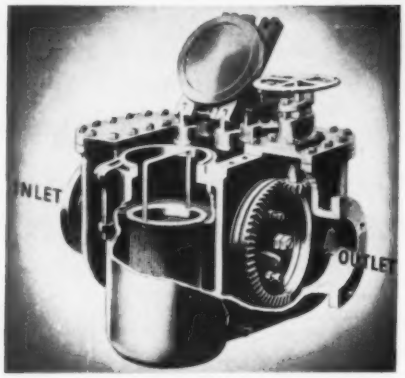

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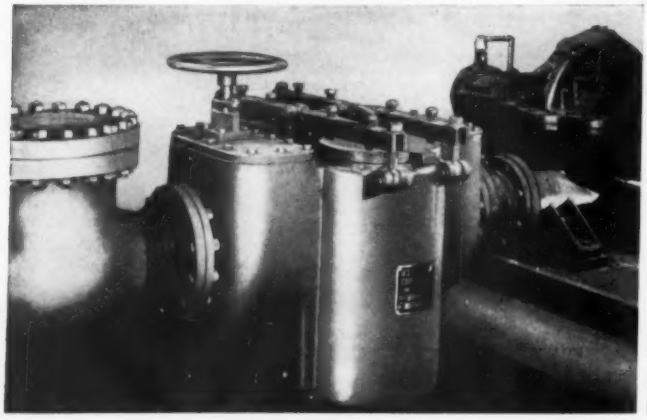

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New ENGINEERING BOOKS

Selling to Industry, by Bernard Lester; 1st edition; 255 pages; size 4½ by 6⅞ in., leather binding; published by the Industrial Press, 148 Lafayette St., New York 13, N. Y.; price $3.50.

This is a compact, pocket manual of practical ideas and suggestions for the sales engineer who wants to analyze and improve his method of finding, contacting, selling and servicing industrial customers.

The book is written in the form of short easy-to-read articles, which are grouped in a series of sections entitled: Prospects are Our Market; Just How do Prospects Buy; Sales Program Essentials; Make the Sales Program Effective; Successful Sales Interviews; Sell the Prospect's Employees; Be a Better Equipment Salesman; Getting Help from Others; Use all Our Sales Tools; Meet the Prospect's Objections; Follow Up the Customer's Decision; Grow in Power and Sales Skill; and When Orders Hang on Trees.

Mr. Lester writes from a wealth of experience as a sales executive for Westinghouse Electric Corp., lecturer on sales engineering and marketing at the University of Pittsburgh, Stevens Institute and Brooklyn Polytechnic Institute and as a consultant on machinery and equipment marketing and selling. From this background, he states in his introduction that selling any prospect effectively does not follow a beaten path. Prospects and salesmen vary in temperament, habits, and interests. Also, different products have different problems. But success in selling is not a haphazard affair. Proper preparation and orderly enthusiastic procedure are necessary.

At a time when industrial equipment and machinery are in heavy demand, with large backlogs of orders building up in many cases, it would seem that the need for sales guidance and training was not very great. Mr. Lester, however, presents sound and convincing reasons for continued, planned sales and service effort regardless of the present-day market prospects.

This book seems well suited for adoption by industrial concerns as a training manual for their sales engineers.

Nomography and Empirical Equations, by Lee H. Johnson; 1st edition; 150 pages; size 5¾ by 9 in., cloth binding; published by John Wiley & Sons, Inc., 601 West 26th St., New York 1, N. Y.; price $3.75.

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sional practice and research. These data are required for the development of new techniques and equipment as well as for analysis and control of current operations. A good working knowledge of two techniques for handling these data, (1) nomographs and (2) empirical equations, is useful not only to engineers, and scientists, but also to industrialists and to doctors, and other professional groups engaged in experimental research.

Professor Johnson has chosen what he considers the simplest and most direct approach to the use of nomographs and empirical equations. You will find a carefully prepared and thorough treatment of the factors involved in the actual construction of specific nomographs. Emphasis is on step-by-step progress from elementary to more complex factors plus strict attention to detail. He also introduces for the first time, a method of analyzing an equation and its variables before plotting in nomographic form, in order to determine the best arrangement of scales. And another innovation is a discussion of the effect of scale arrangement on the accuracy of a nomograph.

Professor Johnson shows how to apply nomography and curve fitting to a wide variety of problems in science and engineering as well as in many phases of business and industry such as research and development, production, sales, and management, where it is necessary to make time-consuming calculations.

Heating, Ventilating, Air Conditioning Guide 1952; 30th edition; 1520 pages; size 6 by 9 in.; leather binding published by The American Society of Heating and Ventilating Engineers, 62 Worth Street, New York 13, N. Y. Price $7.50.

This edition of The Guide has 32 pages of new data added to what was contained in the previous edition, plus numerous improvements. It contains technical and design information on 50 subjects. The entire volume has been reviewed carefully and important revisions have been made throughout. The chapter arrangement of the past two editions has been retained, chapters being grouped under the familiar section titles; I Fundamentals; II Human Reactions; III Heating and Cooling Loads; IV Combustion and Consumption of Fuels; V Systems and Equipment; VI Special Systems; VII Instruments and Codes.

New codes of interest and latest editions of all codes have been included in the enlarged list of codes and standards. Names and addresses of organizations which can supply the codes and standards are listed for convenience for obtaining copies.

One of the special features of The Guide is the larger Catalog Data Section which contains accurate data and specifications on the latest products of 277 manufacturers. For the convenience of finding avail-

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able types of equipment there is a 32-page index to modern equipment.

This edition was prepared by the Guide Committee, composed of: Chairman, P. B. Gordon; D. B. Anderson; Prof. N. Glickman, Prof. W. S. Harris; Prof. B. H. Jennings; Prof. W. E. Long; P. J. Marschall; F. J. Nunlist, Jr.; C. D. Shields; ex-officio, Cyril Tasker; and Technical Secretary, Carl H. Flink.

Exhaust Hoods by J. M. Dalla Valle; 2nd Edition; 146 pages; size 6 by 9 in.; cloth binding; by The Industrial Press, 148 Lafayette St., New York 13, N. Y. price $3.50.

For information on exhaust hood design, this book is a good primary source of data, based on the author's own experimental investigations on the flow of air around and into the openings in exhaust ventilating systems. Backed by over 20 years' experience in the field of industrial hygiene, it is a concise assembly of both fundamental theory (including the latest thinking along the lines of what is known as the dilution concept) and of practical applications of theory to the actual design of hoods for all types of industrial installations.

Four chapters are devoted to the various aspects of theory, including flow of gases, velocity characteristics of canopy hoods, and criteria for determining hood effectiveness. Five chapters cover actual hood design for various types of applications. Other chapters cover booth-like structures, grille openings, woodworking machinery, examples of hood design calculations, entrance losses, and the essentials of good construction. Sample problems, with the solutions worked out in detail, are given in a chapter devoted entirely to this matter.

All-Purpose Diesels, by J. Malcolm Robson; 1st edition; 316 pages; sizes 6 by 9 in.; cloth binding; published by Pitman Publishing Corporation, 2 West 45th St., New York, N. Y. price $10.00.

This book is written by an acknowledged expert and presents a comprehensive technical survey of the design and practical applications of Diesel power units. Particular attention is given to the many practical uses of oil engines because, in these days of all-purpose units, such requirements have a material effect on engine lay-out and appearance. Other sections deal with the development of oil engines, together with equipment for their starting, cooling, governing, and power transmission. The book is well illustrated and contains many useful tables. Diesel engine operators, and all concerned with this branch of engineering will find the book of the greatest value.

ASTM Standards on Copper and Copper Alloys sponsored by ASTM Committee B-5; 520 pages; illustrated; size 6 by 9 in.; paper binding; published

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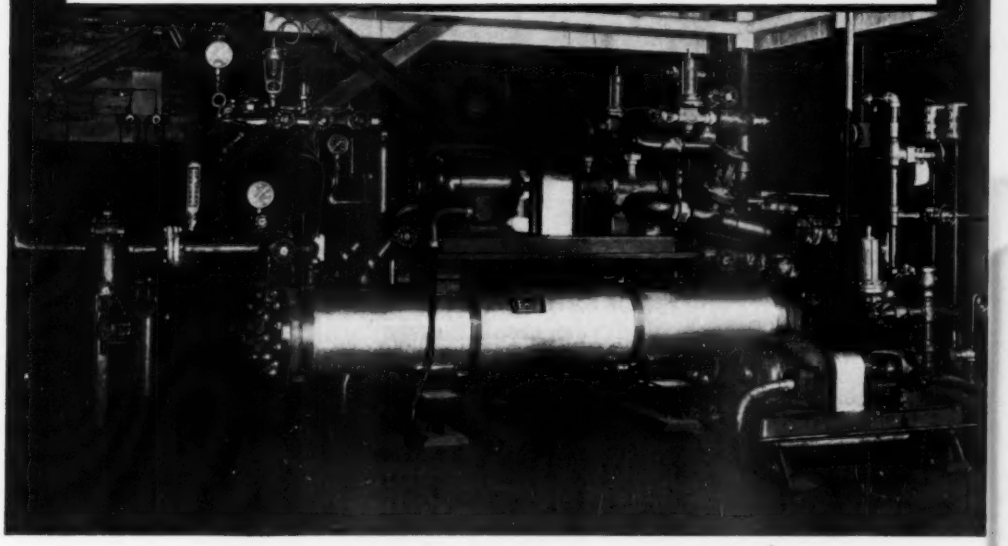

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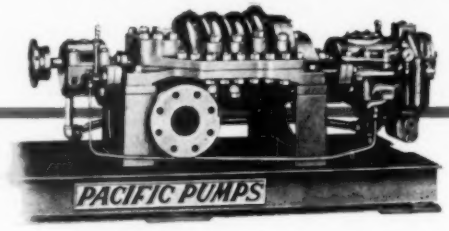

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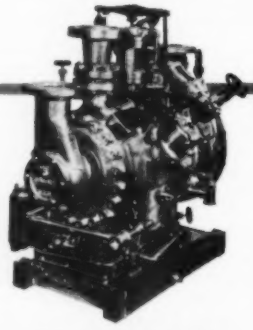

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by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price — paper cover $4.75; cloth cover $5.40.

This latest edition, as of February 1952, brings up to date all ASTM standards on copper and copper-base alloy products that were developed by Committee B-5 on Copper and Copper Alloys, Cast and Wrought, and other ASTM technical committees. The 114 specifications and test methods described in the book cover plate, sheet, rolled bar and strip; rod, bar and shapes; pipe and tubes; wire, sand and die castings; arc-welding electrodes and brazing solder; standard nominal diameters and cross-sectional areas of American Wire Gage (AWG) sizes of solid round wires as electrical conductors; stranded conductors and other electrical usages of copper.

A group of specifications cover nonferrous metals such as slab zinc; pig lead; nickel; and others.

Also included are test methods covering expansion, resistivity, hardness and other characteristics. Recommended practices are given for tension test specimens for copper-base alloys, for sand castings and designating significant places in specified limiting values.

1951 Supplement to Book of ASTM's Standards, Including Tentatives; six parts; pages as listed; size 6 by 9 in.; paper binding; illustrated; published by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price $3.50 per part; $21.00 for complete set of six parts.

Part 1. Ferrous Metals. 416 pages. Includes 54 standards covering steel piping materials (welded and seamless; high-temperature service; stainless, etc); steel tubes (heat-exchanger and condenser; still tubes for refinery service; seamless and welded for low-temperature service, etc); structural and plate; bars and bolting materials; boiler rivets; forgings; music wire and alloy bars for springs; corrosion and heat-resisting steels; metallic coated steel products; cast and malleable iron; general testing methods.

Part 2. Non-Ferrous Metals. 360 pages. Includes 75 standards covering copper and copper alloys (wire, bars, and stranded conductors for electrical purposes; plate, sheet, strip, and rolled bar; wire, rod, bar and shapes; pipes and tubes; alloy castings); aluminum and magnesium alloys for castings; metal powders and products; electrical heating, resistance and related alloys (materials for radio tubes, electronic devices and lamps; thermostat metals); electrodeposited metallic coatings; general testing methods.

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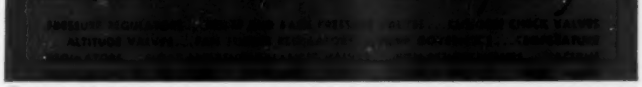

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Part 4. Paint, Naval Stores, Wood, Adhesives, Paper, Shipping Containers. 264 pages. Includes 46 standards covering pigments (white, mineral iron oxide and metallic); drying oils and thinners; shellac, varnish, lacquer and related products; traffic paint (roundness of glass spheres); paint weathering and general paint tests; naval stores (rosin and liquid); wood; adhesives; paper and paper products; shipping containers (pallets); strength tests of panels for building construction; general testing methods.

Part 5. Textiles, Soaps, Fuels, Petroleum, Aromatic Hydrocarbons, Antifreezes, Water. 344 pages.

Part 6. Electrical Insulation, Plastics, Rubber. 248 pages. Includes 33 standards covering electrical insulating meterials (varnish; nonrigid polyvinyl tubing; hydrocarbon waxes; fabrics; mica stampings); plastics (definitions of terms; strength, hardness, and thermal properties; conditioning; molds and molding compounds); rubber products (chemical and physical tests; aging and weathering; low-temperature stiffening; automotive and aeronautical rubber; hose, belting and hard rubber; sponge and expanded cellular rubber products); general testing methods.

Manual of ASTM Standards on Refractory Materials, prepared by ASTM Committee C-8; 304 pages; size 6 by 9 in.; illustrated; paper binding; published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price $3.00, paper cover; $3.65, cloth.

This book brings together in latest approved form 37 ASTM standard and tentative specifications, classifications, test methods, and definitions pertaining to refractories.

It includes data on testing and use of refractories not in the category of ASTM standards, such as a suggested procedure for calculating heat losses through furnace walls; suggested practice for use with ASTM panel spalling tests; suggested petrographic techniques; standard samples for chemical analysis and pyrometric cone equivalent determinations; and 12 industrial surveys of refractory service conditions.

New material includes methods of test for modulus of rupture and for permanent linear change on firing of castable refractories; proposed test method for disintegration of fireclay refractories in atmosphere of carbon monoxide; survey or

refractory service conditions in the incineration of refuse; glossary of terms relating to refractories, their manufacture and use. The book has a subject and author index.

Writing for Business, by C. W. Wilkinson, J. H. Menning and C. R. Anderson; 348 pages; size 6 by 9 in.; cloth binding; published by Richard D. Irwin, Inc., 3201 S. Michigan Ave., Chicago 16, Ill. Price $4.00.

The authors of this book are, respectively, professors at Michigan State College, University of Alabama and University of Illinois. The book contains selected articles on business communication by the various authors. It is planned as an aid to all who write business letters and that means practically everybody, and it is dedicated to the improvement of business correspondence. It contains over 60 articles on the theory and technique of business communication appearing in the business magazines in recent years.

Business firms desiring to improve their company correspondence will find this book a convenient guide to the latest trends and developments and the basic principles of good letter writing. It can profitably be used for individual study or for a formal training program.

The book is divided into ten parts covering the following general subjects: I — Basic Principles of Letter Writing; II — Attitude of the Writer Toward the Reader; III — Planning Letters for Clearness, Conciseness and Psychological Effect; IV — Language of Business; V — Inquiries and Acknowledgments; VI — Selling by Mail; VII — Letters That Get Jobs; VIII — Adjustment Letters; IX — Credit and Collection Correspondence; and X — Correspondence Supervision and Control.

Materials Surveys, compiled for the National Security Resources Board by the U. S. Bureau of Mines; 4 surveys; size 8 by 10½ in.; paper binding; illustrated; obtainable from Superintendent of Documents, Sales Office, Washington 25, D. C. Prices: Antimony, $1.25; Asbestos, $1.75; Lead, $3.50; Nickel, $2.00.

These four major studies of strategic materials cover antimony, asbestos, lead and nickel. A separate volume for each consists of a worldwide survey with detailed statistics on resources, methods, production, marketing, and consumption.

Basic reference data includes mine and smelter output by each producing country and by states within the United States. Imports by country of origin, exports, consumption in various forms by end use both here and abroad are included.

Of particular interest are sections dealing with the producing mines in each country and their ore reserves, as well as smelting and refining facilities in each country and their capacities. Many of the statistical tables cover the period from 1900 to 1950. A volume on zinc will be published in the near future.

Electrolytic Manganese and Its Alloys, by Reginald S. Dean; First Edition; 257 pages; 6 by 9 in.; cloth; published by The Ronald Press, 15 E. 26th St., New York 10, N. Y.; 1952. Price $12.00.

This book is a record of the progress of electrolytic manganese production and the developments of its uses since 1936, when a practical method for producing electrolytic manganese was first developed under the author's direction at the Bureau of Mines.

The discussion deals with the production of electrolytic manganese to the properties and uses of alloys in which manganese is necessary, and to alloys in which electrolytic manganese produces significantly different properties from the use of other types of manganese. Much of the material is drawn from published reports of the Bureau of Mines, to which has been added a substantial amount of hitherto unpublished material from the author's own laboratory work. Effort has also been made to include reference to all work which has been done in the field. The result is a comprehensive working reference volume, bringing together information on a process which can well

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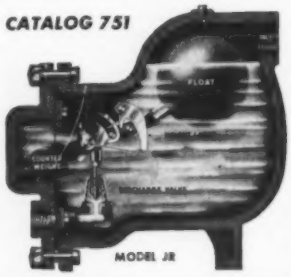

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Electric Machinery, An Integrated Treatment of A-C and D-C Machines, by A. E. Fitzgerald and Charles Kingsley, Jr.; First Edition; 702 pages; 6¼ by 9¼ in.; illustrated; cloth; published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.; 1952. Price $8.50.

During the past 25 years a large number of books on electrical engineering have been written; indeed, there is a steady stream of them that appears all but unending. All of these books have some merit, and, in general, they are intended to meet different needs. Perhaps the greatest need for these books is to keep pace with the extremely rapid and spectacular developments in nearly all branches of the electrical art.

Among other advances, recent years have seen a tremendous development in electrical machinery — developments which have specially highlighted the versatility and controllability of electric motors and generators with their associated auxiliaries. These developments embrace both the large machines required to furnish the high powers and energies demanded by some industrial processes and the smaller electromagnetic devices which play essential roles in systems of machines. They make the machine and the vacuum tube companions in arms in meeting the exacting performance standards of modern industrial applications. They also make it necessary to regard the machine not simply as a static device, grinding out an essentially constant number of kilowatts, but as a dynamic device capable of responding with precision to the spontaneous demands of the process being implemented.

These continuing developments create the need for new viewpoints and a new synthesis of machinery theory, and this book is the result of an intensive six-year program having these ends in view. To achieve the desired results, the authors have considered it of primary importance to present a unified theory of machinery. It highlights the basic principles common to all rotating electric machines, as well as to a wide variety of electromechanical energy-conversion devices. This basic theory is then applied to d-c synchronous polyphase induction and single-phase machines, together with Amplidynes, Rototrols and Selsyns. Transformers are included because of the many similarities in thought processes involved in their study. The treatment ends with introductions to machine transients and to the dynamics of electromechanical systems.

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The authors are both Associate Professors of Electrical Engineering at the Massachusetts Institute of Technology and their wide teaching experience has enabled them to put out a very valuable and understandable textbook. A book not only of interest to students, but to practicing engineers as well.

Transient Electric Currents, by Hugh Hildreth Skilling; Second Edition; 361 pages; 6 by 9¼ in.; illustrated; cloth; published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.; 1952. Price $6.00.

Energy cannot be transformed from one state to another instantaneously. It takes time, for example, for a locomotive to bring a train to full speed. It must add gradually to the kinetic energy of the train as the speed increases. An automobile comes slowly to a stop after the brakes are applied, while the kinetic energy is being changed to heat by virtue of friction. A stone, shot from a catapult, is accelerated during a short but finite length of time during which the potential energy of the spring or rubber band is being changed to kinetic energy in the stone.

These intervals are spoken of as transient intervals as distinct from the final steady state. In electrical circuits, change in the form of energy also must be made gradually. When we close a switch, the electric current is not established instantly. Depending upon the nature of the circuit, a certain amount of time elapses before the current reaches steady state, and similarly when a switch is opened, the current does not come to rest instantly. It endeavors to keep going and this is manifested by the spark or arc which occurs at the switch contacts.

As every electrician knows, these arcs, which appear at switch contacts and circuit breaker contacts, can create quite a lot of disturbance under certain conditions and it requires elaborate precautions to keep it under control.

It is the study of what happens in electrical circuits during these short intervals when the intensity of the electric current is changing that this book, by Dr. Skilling, is concerned with. Transient phenomena in electrical circuits have become of increasing importance through the years as transmission lines have become longer, voltages higher and the amount of power handled greater. Similarly, in electronic circuits, where we are involved with oscillatory conditions, transient phenomena becomes of utmost importance and no one working in these fields can expect to succeed without a good fundamental knowledge of transients.

In this book Dr. Skilling, who is Professor of Electrical Engineering at Stanford University, gives special attention to basic principles. He treats the general methods of the solution of transient problems with many specific examples for the purpose of preparing the student to attack with confidence any sort of transient problem that may arise. Of course, to do this it is necessary to use mathematics and to understand the book it is necessary to have at least an elementary knowledge of calculus and as much electricity as is commonly taught in a general physics course.

Since the First Edition of this book was published, circuit analysis by the Laplace transformation has been developed into an effective tool. One of the major purposes of the Second Edition has been to present the Laplace transformation method of solution of transient problems, in addition to the more familiar treatment that has come to be called the Classic Method. Professor Skilling has taken great care to make the Laplace transformation readily intelligible to students with an engineering point of view. The Laplace transformation is first related to familiar ideas, such as the Fourier series, and is then developed to make it readily useful in solving problems.

Proceedings of the National Electronics Conference, 1951, Volume VII; 736 pages; Charts; Diagrams; 9¼ by 6¼ in.; cloth; published by the National Electronics Conference, Inc., 852 E.

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83rd St., Chicago 19, Ill. Price $5.00.

This book contains the papers or digests of papers presented at the 1951 National Electronics Conference, held in Chicago in the fall of 1951. The 79 papers cover electronic research, development and application in audio systems, components, computers, high frequency measurement, information theory, magnetic amplifiers, medical and industrial applications, micro-wave and propagation, servo theory, signal detection, television and electron tubes.

Electrical Engineering, Theory and Practice, by William H. Erickson and N. H. Bryant; First Edition; 523 pages; 6 by 9¼ in.; illustrated; cloth; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; 1952. Price $6.00.

The constant stream of new texts and handbooks on electrical engineering makes it difficult to evaluate the respective merits of some of the individual volumes. Some are good in one respect, some in others, depending upon the specific need for which they were written. Books dealing with specialized branches of the field are usually detailed, but they require considerable background knowledge of the field in general. This new book by Professors Erickson and Bryant, both of Cornell University, is not a specialized book. It covers the entire field of electrical engineering from a general standpoint and it does it very well. It is divided into three general categories — circuits, machines and electronics — in the order of their presentation. Both direct current and alternating current circuits are discussed in a general way before any consideration is given to machine details. Wherever possible basic relations are introduced in a general form before applying them either to d-c or a-c circuits. In addition to the ordinary d-c and a-c machinery, the general theory and application of synchro units and rotating amplifiers are included. The chapters relating to electronics are intended to serve as an introduction to industrial electronics. A short chapter on communications is included, since communication circuits incorporate many components considered elsewhere in the book.

The book is clearly written and involves a minimum use of mathematics. Of course, mathematics could never be left out of a book dealing with electrical engineering, but for the most part the mathematics are quite simple, consisting of algebra and trigonometry, with a little calculus thrown in where it is necessary.

Emphasis is placed upon those factors which influence intelligent application or selection of equipment. Little stress is placed upon design detail. Certain methods of treatment, such as the equivalent circuit concept for a-c machines, have been omitted because it is felt that these

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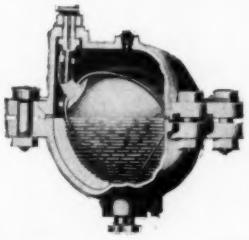

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methods do not contribute to the students' understanding in proportion to the time necessary to gain facility with such methods. Similarly, a-c circuit theory is developed without complex notation; however, an appendix is included on complex notation for those who prefer this approach.

In short, this is a good book for the beginning student, and also for those in the field who wish a text to refresh themselves from time to time with certain basic principles. The book covers all fundamentals necessary for a firm grasp of the subject and it has been in use at Cornell for several years where students' reactions and performance were most encouraging.

Electrical Code Diagrams by B. Z. Segall. Size 8¼ by 11 in.; 343 pp excluding index; illustrated; cloth bound. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Price $12.50.

This large volume is an aid to a better understanding of some of the contents of the latest (1951) National Electrical Code. Its many clear diagrams help interpret different rules that appear in the code. In many cases text material is presented to further enlarge on different code conditions.

The book covers wiring design and protection, and wiring methods and materials. Theoretical and practical aspects are both presented. The contents with the many years experience behind its preparation should make this volume a useful addition to a plant engineer's library.

New Engineering Books Received

To be Reviewed in Detail Later

Handbook of Engineering Fundamentals, edited by Dean Ovid W. Eshbach; Second Edition; 1324 pages; illustrated; size 6 by 8¾ in.; simulated leather cover. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price $10.00.

★ ★ ★

The Nature of Some of Our Physical Concepts, by P. W. Bridgman; 64 pages; size 6¼ by 9¼ in.; cloth binding. Published by Philosophical Library, Inc., 15 East Fortieth St., New York, N. Y. Price $2.75.

★ ★ ★

A New Theory of Gravitation, by Dr. Jakob Mandelker; 25 pages; illustrated; size 5¾ by 8¾ in.; cloth binding. Published by Philosophical Library, Inc., 15 East Fortieth St., New York, N. Y. Price $2.75.

★ ★ ★

Electrical Engineering, Volume I — Direct Currents, by Chester L. Dawes; Fourth Edition; 736 pages; illustrated; size 6¼ by 9¼ in.; cloth binding. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 17, N. Y. Price $7.00.

HELPFUL BULLETINS

(*Continued from page 38*)

tells how the cost of operating an air conditioning system is cut and maintenance simplified if consideration is given to the part played by water in the functioning of the system. Discusses corrosion, scale formation, chemical treatment, cleaning. Water Service Laboratories, Inc.

HEATING

129 Heat-on-Wheels for Industry — Illustrated Form 3574, 16 pp, is the story of how manufacturer's portable heaters can solve emergency heating problems. Shows how these heaters provide extra heat for the hard-to-heat spots, and for extra cold areas, to spot heat where needed, and for ventilating, drying and thawing jobs. Filled with photos of these heaters at work. Herman Nelson Div., American Air Filter Co., Inc.

130 Indirect Heaters — Primarily designed to help in the selection of the most efficient heater for job requirements, 38-pp Catalog C-101 gives a complete description of company's "70" series and Junior indirect heaters, their uses, advantages, construction, capacities and specifications, dimensional drawings and standard equipment furnished with each model. Describes such important accessories as extra long chokes and fuel gas regulators. Shows how to select right size heater. Black, Sivalls & Bryson, Inc.

MAINTENANCE

131 For Above-Ground Maintenance — A practical equipment selection guide rather than an ordering book, 6-pp Bulletin G-205 is titled, "Controlling Costs when Maintenance Goes Above's Arm's Reach." Details basic factors and conditions to be considered in determining most efficient equipment to place men at working height readily and safely for easiest working conditions. Profusely illustrated. The Patent Scaffold Co.

132 Scaffolding Equipment — Illustrating in detail a complete line of steel scaffolding equipment, Form KP is divided into sections covering maintenance scaffolding, sectional steel scaffolding, and allied equipment. Applications and specifications of each are covered together with "package" units for specific types of jobs. Wilson-Albrecht Co.

133 Maintenance Manual — "Over the Rough Spots" is a 48-pp pocket size booklet giving the answer to practically every repair or building maintenance problem. Tells how to patch holes and resurface floors, prevent water seepage in underground foundations, repair leaky roofs, preserve concrete or wood surfaces, protect structural steel from rusting, and gives many time and saving methods in solving maintenance problems. Generously illustrated with how-to-do-it photos and sketches. Stonhard Co.

134 Paints for Laundries — No. 8 in a series of booklets on industrial maintenance covers paints and coatings engineered for the laundry industry. Some 19 products are described as to application, performance under cleaning solutions, light reflectivity etc. Space is also devoted to discussion of importance of preparation and priming. A selector table included. Valdura Div., American Marietta Co.

135 Scale and Rust Removal — Practical suggestions on removing hard water scale and rust deposits are provided in Form 4305, a pocket-size 28-pp booklet, featuring company's Compound 32. Discusses this formulation, gives general instructions for use, safety measures to be observed. Gives procedure for use on a wide range of equipment — condensers, compressors, diesel engine cooling systems, meters etc. Oakite Products, Inc.

INSTRUMENTS AND CONTROLS

136 Electronic Recorders — Bulletin A-704, 6 pp, covering company's Autronic recorders, is generously illustrated with photos, schematic diagrams showing principles of operation, and dimension sketches. The Swartwout Co.

138 Metering for Profit — Explaining the important influence of modern metering on the revenue of the electric power industry, this handsomely illustrated 20-pp brochure serves as a nontechnical report on watthour meters. Tells how they're made, how they serve the power company's interests most effectively. Sangamo Electric Co.

139 Push-Pull Control Systems — Form AD-311 is a 12-pp manual covering all phases of manufacturer's versatile push-pull control. Illustrated with many photos, drawings and tables, booklet covers construction features, types of installations, design details, principal components and layout planning. Design information given. Simmonds Accessories, Inc.

OTHER EQUIPMENT

140 Soot Blowers — Eight-pp Bulletin 1002 illustrates and describes long retractable soot blowers, with air and electric drives. These blowers are suitable for travels of more than 20 ft and blow with steam or air without change in original equipment. Tells how these blowers operate. Copes-Vulcan Div., Continental Foundry & Machine Co.

141 Bag Holders — Six-pp Bulletin 0452 covers four different types of holders for securing bags to hopper outlets during filling. Includes photos and gives operating details and recommended applications for clamp, inflated-ring, cable and cam grip types of holders. Covers high-speed filling operations, handling of toxic materials. Richardson Scale Co.

142 For Economical Continuous Power — Spark ignition, totally enclosed gas engines are the subject of Bulletin S-550-B18A. This is a four-cycle engine of compact design and several installations are pictured. Ratings, specifications and principal dimensions accompany text. Worthington Corp.

143 Hardenable Steels — Two economical ferritic stainless tubing steels having resistance to corrosion and oxidation and ability to be hardened by heat treatment are discussed in Technical Data Card 143. Includes condensed technical data on corrosion resistance, mechanical properties, forging, machining, physical properties etc. Tubular Products Div., The Babcock & Wilcox Co.

144 Mechanical Seals — Excellent data on the design and use of mechanical seals for centrifugal pumps is provided in Bulletin 52-10000, 12 pp. Three types are presented: a low pressure single seal, an oil-lubricated double seal, and a balanced high pressure single seal. Cutaway drawings illustrate use of these seals. Bryon Jackson Co.

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Catalog Library

THIS MONTHLY list of standard catalogs and bulletins is published to help power engineers maintain a permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, may appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the catalogs and bulletins. Use the postage-free card below for your request

COAL, ASH HANDLING

201 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

202 Where Refuse Is Fuel — Presented in 24-pp Bulletin are installations of company's stokers with medium-size and larger units burning refuse fuels, separately or in combination with coal. Lists many of the refuse fuels handled successfully by this type of spreader stoker. Detroit Stoker Co.

203 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. Shows how beam system, electrical components and linkages are protected from exposure to coal dust. Richardson Scale Co.

205 Economic Coal Storage — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses flexibility, low operating costs. Also shows how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; picture several models. Tractor Div., Allis-Chalmers Mfg. Co.

207 Why Liquid Diffusion — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly ash control, coal storage pile treatment and boiler cleaning. Johnson-March.

BOILERS, GENERATORS

208 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76, completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. Savings in erection, installation and moving costs are stressed along with wide range of applications. Capacities, dimensions and weights are given along with efficiency data. The Babcock & Wilcox Co.

209 Re-Circulation Steam Generator — Here's a 6-pp folder on a controlled re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or load fluctuating. Combustion Engineering-Superheater, Inc.

211 Steam Generator — Bulletin 1050 describes a fully automatic generator in 10 to 500 hp capacities furnished completely equipped ready for installation. Cutaway drawing illustrates design of the unit; major parts are discussed, full dimensions included. Lists fuel burning equipment provided for use with light and heavy oils, gas, or combinations. Ames Iron Works.

TUBING

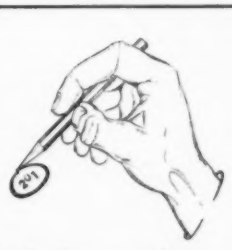
213 Double-Walled Tubing — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations. Explains tubing's use in ammonia refrigeration, boilers, steam generators. Discusses heat transfer properties, high temperature use. Bridgeport Brass Co.

215 Condenser Tubes — Excellent factual information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Details on proper tube installation are presented, as are specifications, conversion tables, weights of tubes and alloys, formulas, terminology. Scovill Mfg. Co.

PUMPS AND COMPRESSORS

217 Centrifugal Pump Handbooks — Two instruction booklets covering the installation, operation and repair of company's single-stage single-suction and multi-stage centrifugal pumps are available. Suggest regular inspection procedures and include pages for maintenance records. Also provide handy tables explaining how to locate trouble and listing causes and cures. Bulletin 08X7813, 24 pp, covers single-stage pumps; Bulletin 08X7780, 48 pp, covers the multi-stage pumps. State choice or both. Allis-Chalmers Mfg. Co.

219 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major



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190 ANDERSON STEAM TRAPS
183 ANDERSON STRAINERS
62 AIR RELEASE VALVES

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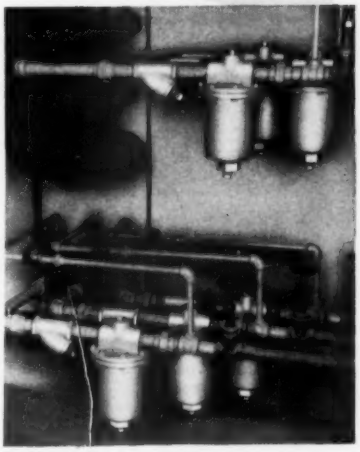
Where speed of installation and servicing, as well as absolute dependability, are prerequisites, Super-Silvertop Steam Traps get the nod! Chosen for the Greater Pittsburgh Airport, Super-Silvertops offer these outstanding features.

1 Super-Silvertops are installed quickly straight-in-line as seen in the photo at the right . . . or as an elbow. Saves time. Saves fittings. Saves money.

2 Look at the photo again. See how you can take a Super-Silvertop apart for inspection and replacing of valve and seat without disturbing the pipeline in any way. Another Super-Silvertop money-saving feature.

3 Inside the trap a patented guided bucket protects the bucket . . . this plus an exclusive Anderloy valve and seat makes the trap last years longer.

You'll make a perfect landing every time you specify and install Super-Silvertops. Do it on your next job.



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parts, floating seal incorporated. Capacity data, vapor pressure tables included. Pacific Pumps, Inc.

222 Compressor Selection Chart — Based on normal applications handling air with atmospheric intake pressure, this chart simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute. Worthington Corp.

PACKINGS, GASKETS, SEALS

224 Manual on Packings — Containing 84 pp of engineering and ordering information, Catalog 40 covers packings for practically every service. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

225 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

226 Packings for the Power Plant — Designed as a quick-reference aid, one feature of this compact 6-pp guide is a flow sheet of a rudimentary industrial power plant with each unit keyed to the proper packings and gaskets. These, in turn, are illustrated with photos and construction information, sizes, etc. Packings and gaskets are grouped according to recommended applications and services. Johns-Manville.

227 Seals for Bearings — Complete information on manufacturer's Klozure oil and grease seals for bearings is available in 100-pp Catalog 10. Fully illustrated in color, pictures all types of these seals, typical applications and lists sizes and part numbers. Also describes mechanical pressure seals for rotary shafts. The Garlock Packing Co.

228 To Pack Against Acid — A packing that is chemically resistant to all acids, alkalies and caustics is described in this literature. Tells how packing incorporates both asbestos and Teflon in its construction, stresses advantages. A. W. Chesterton Co.

VALVES, TRAPS, PIPING AND ACCESSORIES

229 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principle of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

230 Gate Valves — Literature is available on cast steel outside-stem-and-yoke gate valves; also on bronze, iron, steel and corrosion-resisting valves in a variety of types. The Wm. Powell Co.

231 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all sizes of valve wheels. Babbitt Steam Specialty Co.

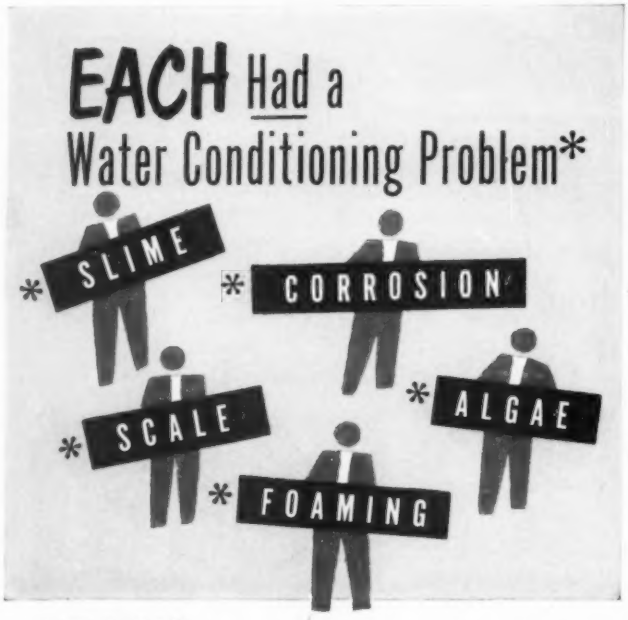
232 Iron Body Gate Valves — Bulletin 805, 8 pp, covers iron body, bronze trim gate valves in both outside screw and yoke and non-rising stem types, telling applications for each. Design features are explained. Gives dimensions, working pressures, and prices. The Ohio Injector Co.

234 Blow-off Valves — Illustrated Bulletin B-433, 24 pp, describes blow-off valves for high-pressure boilers, and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles illustrated. Dimensions and specifications included. Yarnall-Waring Co.

236 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

238 Air Release Valves — Bulletin 1200, 8 pp, presents air release valves for water, sewage and industrial use. Explains essential requirements for this type of valve; illustrates methods of installation. A large cutaway drawing accompanies discussion of the operating and construction details. Standard high pressure and special types described, dimensions given. Simplex Valve & Meter Co.

239 Pressure Reducing Valves — Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are in 12-pp Bulletin 477-A. Northern Equipment Co.



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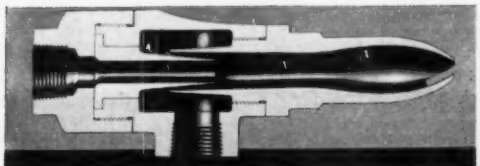

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You get these important advantages: (1) higher torque at any speed because of six-bladed construction; (2) less air consumption with a minimum of back pressure; (3) positive starting—hard to stall; (4) less downtime because tube cleaning jobs are faster, more thorough; (5) saves on labor and keeps production up; (6) no extra cost.

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240 Safety Valve Engineering Data — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, tables on superheat correction factor. Manning, Maxwell & Moore, Inc.

241 Steam Trap Book — Catalog J is the 44-pp new edition of this company's popular trap book and serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

242 Steam Trap Reference Manual — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure trap sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Also provided are installation and operating suggestions, prices. Yarnall-Waring Co.

243 Steam, Air and Gasoline Traps — Illustrated Catalog 751, 32 pp, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostatic steam traps for pressures to 225 lb, expansion steam traps, weight-operated traps for steam, air and gasoline as well as piston-operated steam traps. W. H. Nicholson & Co.

244 Solving Steam Trap Problems — This popular 36-pp catalog on steam traps contains specifications and capacities on steam traps, float traps, air release valves and pipe line strainers. Tells how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, steam mains and header drips. Gives pointers on how to install and service traps. The V. D. Anderson Co.

245 Piping Pointers — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how-to-do-it features. Includes 8 pp valve selection guide. Crane Co.

246 Duplex Strainer — This literature describes company's Duplex strainer with single handwheel control. Shows how it is designed with only one stuffing box and can be cleaned under full flow. R. S. Products Corp.

247 Valves, Fittings and Flanges — Catalog F-9 is a 400-pp, permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides ordering information on company's complete line, also much helpful engineering and application data: includes a section on products for refrigeration service. Available to qualified power engineers; please give your title. Henry Vogt Machine Co.

248 Design Properties of Pipe — This 12-pp booklet consists of tables listing pipe sizes and wall thicknesses currently established as standard, plus dimensional properties of commercially available sizes of steel pipe. Tube Turns, Inc.

249 Handbook on Fittings, Flanges — Catalog wf-1950, 68 pp offers working information on seamless carbon steel welding fittings and forged steel flanges. Includes dimensional tolerances, thread standards and threading practice; service pressure ratings, physical and chemical requirements. Grinnell Co., Inc.

250 Forged Fittings — Literature is available on screw-end and socket-weld fittings. Stresses economy and other advantages of these fittings, lists steels available. Watson-Stillman.

251 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

INSTRUMENTS AND CONTROLS

252 For Centralized Control — Bulletin 109 presents compact Mini-Line equipment suited to control board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes vertical-

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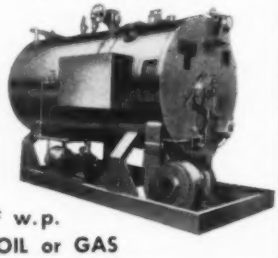

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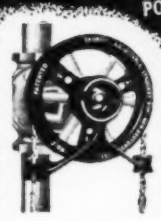

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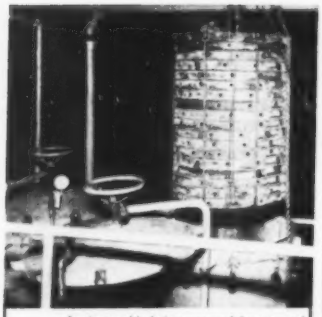

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scale indicator units, selector valve, remote manual relay. Bailey Meter Co.

253 Electronic Control System — Bulletin A-701 introduces company's Autronic system, a miniature all-electronic system for controlling pressure, temperature, flow and level, intended for use in chemical processing plants, refineries, central stations, other applications where fast, accurate control is required. The Swartwout Co.

254 Instruments Control Systems — Twelve-pp Catalog 513 presents manufacturer's line of instruments, control systems, regulating valves and desuperheaters. Covers draft and pressure instruments, boiler meters, recorders, thermometers, regulators, combustion controls, pump controls and many others. Republic Flow Meters Co.

256 For Combining Control Signals — The improved design of company's Ratio Totalizer is described and pictured in color in 8-pp Bulletin 5452. This simplified versatile mechanism is a pneumatically operated control for combining input control pressures and spring forces, and producing an output control pressure based on addition, subtraction, multiplication, division or other functions. Hagan Corp.

258 For Practical Men — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in long run economy. James G. Biddle Co.

259 Industrial Thermometers — Catalog 125, 28 pp, presents ordering data on a wide range of industrial thermometers, giving scale ranges, dimensions and prices. Features company's Adjust-Angle thermometer designed for use at any angle front to back, left or right, through a 180 deg arc. Gives construction details and advantages of this adjustable-stem type instrument. Weksler Thermometer Corp.

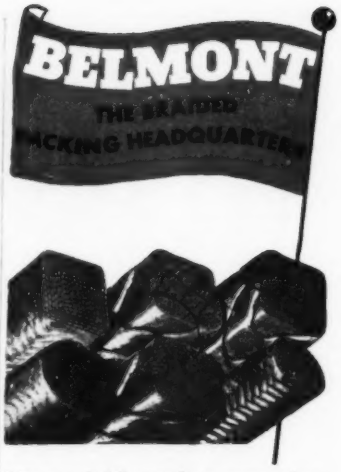
261 Temperature Regulators — Twelve-pp Bulletin T, Catalog 80, describes manufacturer's line of regulators for controlling temperature of liquids and gases, giving their applications, operating characteristics, construction specifications, dimensions. Foster Engineering Co.

262 Pressure Regulator — Bulletin 1-B, 8-pp discusses design, operation and applications of a super-sensitive pressure regulator; shows typical installations. Also covers a compound regulator for controlling back pressure relief valve. Atlas Valve Co.

263 Gage Glasses — This folder describes company's Sonderglass boiler gage glasses available in clear or reflecting types. Tells merits of these handmade glasses, stressing strength of double-layer construction. Includes prices. A. W. Chesterton Co.

FUEL BURNERS

264 Gas Burners — Illustrated Bulletin 410-8, 16 pp, furnishes descriptive and technical data on company's gas burners and combination gas and oil burners, giving design details and explaining operation of each type. Coppus Engineering Corp.



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265 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Discusses steam and oil control valves. National Airoil Burner Co., Inc.

266 Oil Burning Equipment — Bulletin O-B 37 contains 16 pp of technical information on company's oil and gas burning equipment, steam atomizing burners, mechanical atomizing burners, interchangeable burners, telling best applications, including capacity data. Also shows fuel oil pumping, heating systems. The Engineer Co.

FUEL OILS, LUBRICANTS

267 Cooperative Technical Consultation Service — This informative 24-pp booklet presents company's periodic consultation service aimed at the most efficient use of petroleum products. Covers services available in the solution of lubrication problems, metalworking operations, processing, fuel oils, dust control. Gulf Oil Corp., Gulf Refining Co.

268 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, safety precautions. Cities Service Oil Co.

270 Lubrication of Diesel Engines — An excellent instruction manual, 50-pp Technical Bulletin B-1 (revised) also provides a brief history on diesel engines, an explanation of the fundamentals of design and the common types of diesels and their advantages. Explains combustion process, discusses modern fuel injection systems. Cylinder and bearing lubrication are treated and recommendations given for lubricating oils. Sun Oil Co.

272 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.)

REFRACTORIES, INSULATION

274 Refractory Brick — Electric furnace fused refractory bricks and their use is described in Form 862, 16 pp. Gives installation procedure on a high quality silicon carbide brick for boiler furnaces and gas generators. Also provides information on a fused aluminum brick. Norton Co.

275 Heat Insulation — This 8-pp booklet on hydrous calcium silicate insulation is illustrated with graphs, tables and drawings showing the numerous ways in which this insulation is used in industrial and commercial projects for temperatures up to 1200 F. Lists wide selection of shapes and sizes to insulate tubes and pipes from ¼ to 72 in. dia and vessels from 72 in. to 60 ft, also flat surfaces. Gives data on physical characteristics, recommended thicknesses. Kaylo Div., Owens-Illinois Glass Co.

WATER CONDITIONING

277 Chlorination for Power Plants — Form RA-2061-C is a 20-pp technical article, "Recent Developments in Chlorination and Equipment for Power Plants." Discusses such subjects as industrial water chlorination, the desliming processes, air pilot chlorinator operation, organic slimes and scales, chlorine ammonia reactions, chlorine residual recording. Wallace & Tiernan Products, Inc.

278 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blowdown adjustment, test control. Describes equipment. Dearborn Chemical Co.

Postage-free cards for ordering catalogs and bulletins are provided on pages 38 and 132

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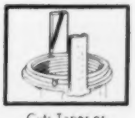
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280 Carryover Prevention — Eight-pp Technical Paper 115 discusses the role of anti-foam agents in the prevention of carryover of boiler water solids with steam. Covers mechanical and chemical influences on carryover, foaming and anti-foam action, types of anti-foam agents. W. H. & L. D. Betz.

281 Water Conditioning Data Book — Recently revised, this pocket-size 116-pp booklet presents a compilation of 77 tables, all valuable to the power engineer. Covers such subjects as hydraulics, impurities in water, boiler feedwater make-up requirements, chemical conversions and chemical reactions. Contains excellent reference information on many phases and methods of water treatment. Available without charge to qualified power engineers. The Permutit Co.

282 What's New on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, 8 pp, Super Nalcolite. State those wanted. National Aluminate Corp.

283 Modern pH and Chlorine Control — This 100-pp booklet gives details on color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

284 Treatment by Ion Exchange — Methods of iron exchange treatment and its general and special applications for water and other liquids are explained in 8-pp Bulletin A. Discusses manufacturer's de-ionizing equipment as to construction and operation and pictures some typical applications. Illinois Water Treatment Co.

285 Organics in Water Treatment — Here's a folder describing need for organics in altering nature of sludge to make it non-adherent. Covers theoretical and practical considerations involved in use of organics. Power Chemicals Div., E. F. Drew & Co., Inc.

286 New Data on Zeolite Softeners — Publication 4520-A is a recently revised edition of company's booklet on zeolite water softening. Provides a glossary of terms used in the process, data for laying out a zeolite softening plant, factors governing size of equipment, selection of zeolite materials and discussion of the four stages of operation of a sodium zeolite softener. Cochrane Corp.

287 For Scale and Corrosion Control — Eleven of company's organic glucoside derivatives are described as to general properties and specific applications in this new bulletin. The various glucosates are now sold in drums ready for use. D. W. Haering & Co., Inc.

288 Water Conditioning Bulletin — This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition. Wright Chemical Corp.

289 Feedwater Treatment — Here is a 10-pp illustrated report on boiler feedwater treatment for a high-pressure, high-makeup power and steam producing plant. It is based on studies to determine best method of meeting requirements for both the high-pressure steam used in power generating turbines and the district heating steam for downtown Philadelphia. Reasons for deciding on a demineralizing plant are given. Graver Water Conditioning Co.

290 Water Conditioning Information — Here are three informational bulletins. No. 28X7446 describes a simple way to determine total hardness in water, illustrating procedure. No. 28X7559 gives an analysis of the hot process-hot zeolite system telling results to be expected. No. 28X4766 discusses current status of embrittlement in boilers, explaining causes and control methods. List bulletins wanted. Allis-Chalmers Mfg. Co.

291 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

292 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are de-

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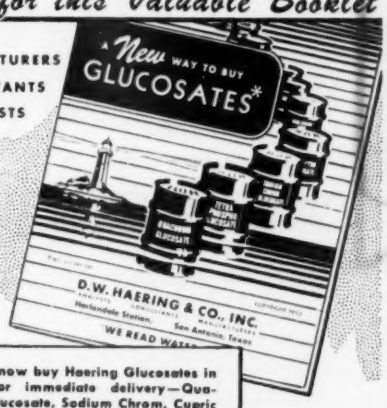

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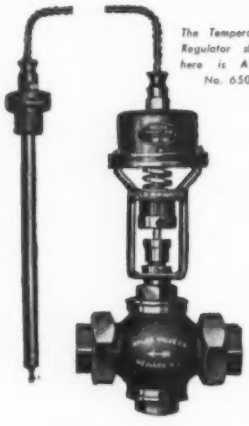

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scribed in Bulletin 1RE50. Procedures, reagents, and equipment are described. Hall Laboratories, Inc.

COOLING

293 Cooling Towers — Bulletin AQ-50 is on packaged water cooling towers in 3 to 50 t sizes. Gives specifications for the tower and discusses special features. Also provides dimensional and application data. The Marley Co., Inc.

294 Spray Nozzle Systems — Recooling spray nozzle systems for use in plants operating condensers or using large quantities of water for cooling, are covered in 8-pp Bulletin 6A-SP. It details design, application, construction, and operation of spray nozzles, and diagrams typical spray pond arrangements. Sizes, dimensions, capacities, and spray nozzle patterns are included. Schutte and Koerting Co.

295 Finned Tube Heat Exchanger — Bulletin 1400, 20 pp, fully describes the company's G-R Twin G-Fin Section heat exchanger. The unit has wide application for heating and cooling liquids and gases, and for condensing vapors, according to the company. Suitable as boiler feedwater preheaters, fuel oil heaters, etc., features of design and construction are given. Specifications and dimensions are included. Many illustrations show representative illustrations along with reports of service records. Griscom-Russell Co.

296 Heat Exchanger — Bulletin 114, a small folder, gives concise information on company's Aero heat exchanger with balanced wet bulb control designed to cool engines or process equipment, coolants and lubricants, liquids and gases for processing operations. Niagara Blower Co.

TOOLS

297 Pipe Tool Book — This catalog and data book gives information on pipe and bolt machines, power units, ratchet threaders, reamers and cutters, other power and hand tools. Includes "operating guide" Beaver Pipe Tools.

298 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Roto Div., Elliott Co.

299 Tube Cleaners — Catalog 76-A provides 48-pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Electrically driven equipment, air valves, hose, lubricators presented. Thomas C. Wilson, Inc.

OTHER EQUIPMENT

300 Friction Tape — Three types of friction tape are described as to properties and application in Form M-8343. They include a high grade tape for all electrical work, a good general purpose tape that's competitively priced and available in two widths, and an extra strong tape. United States Rubber Co.

301 Ejector Instruction Manual — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and maintenance of steam jet air ejectors. Discusses twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back pressures, steam nozzles. Foster Wheeler Corp.

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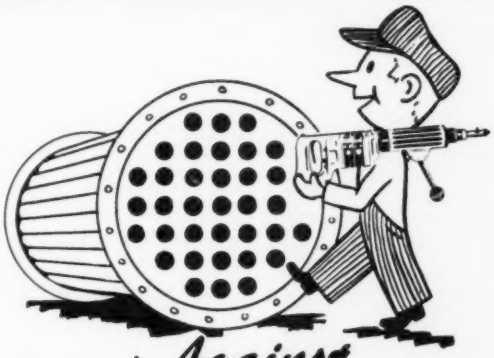

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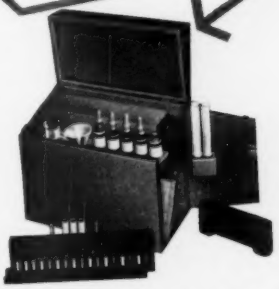

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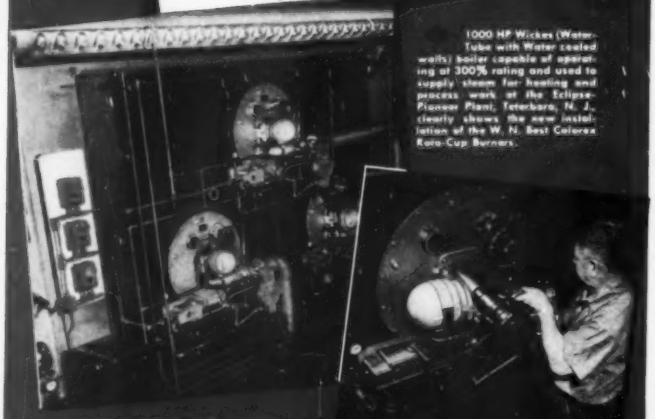

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302 **The ABC of CO_2** — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. Included scales of total heat losses of various types of fuel. The Hays Corp.

303 **Soot Blower Head** — Illustrated Bulletin 485 describes a rotary soot blower head for improved boiler cleaning. Explains how head is designed to give maximum blowing pressure, is rugged, easily serviced, and economical. Copes-Vulcan Div., Continental Foundry & Machine Co.

304 **Mechanical Draft Fans** — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. Gives construction features, shows drive arrangements. The Green Fuel Economizer Co., Inc.

305 **Water Heaters** — Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-, four- and six-pass designs, removable tube bundles. Davis Engineering Corp.

306 **Turbine Generators** — Bulletin H-18, 40 pp, covers turbine-generators of 500 kw and above, pictures nearly 50 turbine-generator installations, both utility and industrial. Brief discussions of generator and exciter cooling methods are included. A reference section offers detailed drawings showing a typical turbine condenser installation arrangement. Elliott Co.

307 **Electrical Maintenance Tips** — Booklet B-5477, 28 pp, gives a complete outline of preventive electrical maintenance. Discusses general maintenance programs designed to reduce shutdown time and treats in detail the maintenance of power equipment. A suggested schedule of work and cleaning on power equipment is presented in chart form. Essential information on preventive maintenance for turbines, generators, switchboards, motors, controls is provided. Westinghouse Electric Corp.

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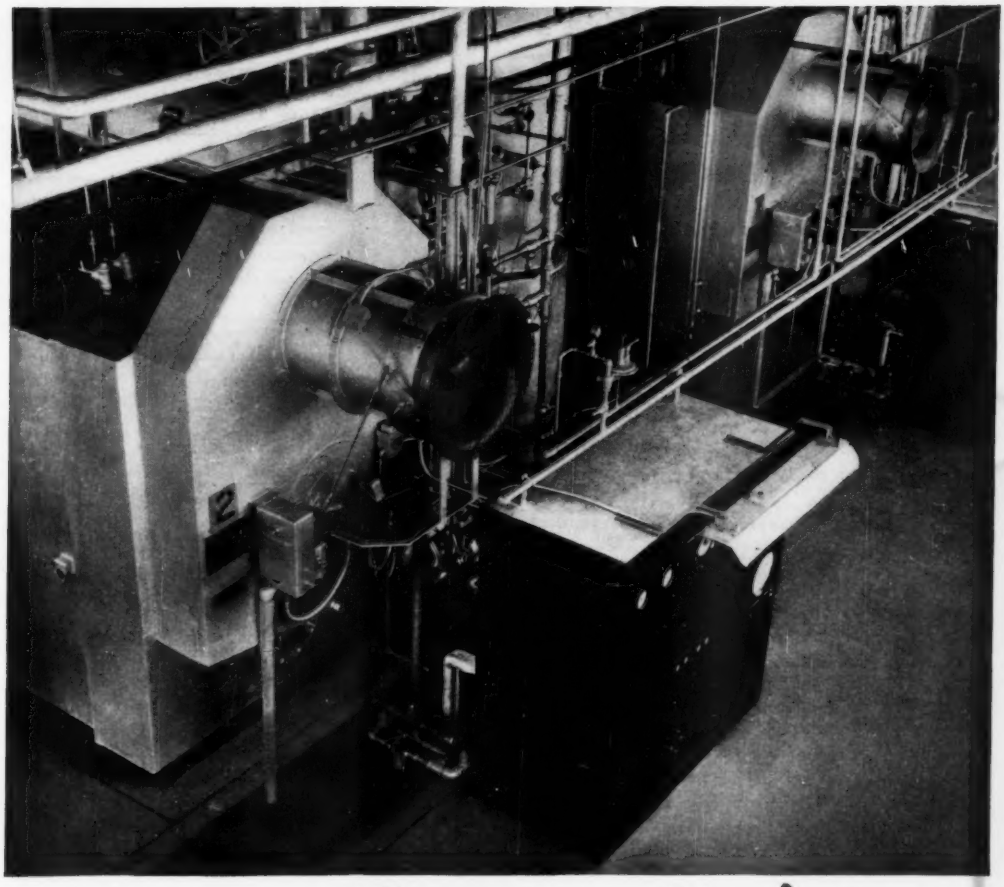

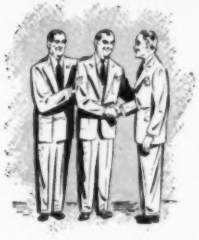

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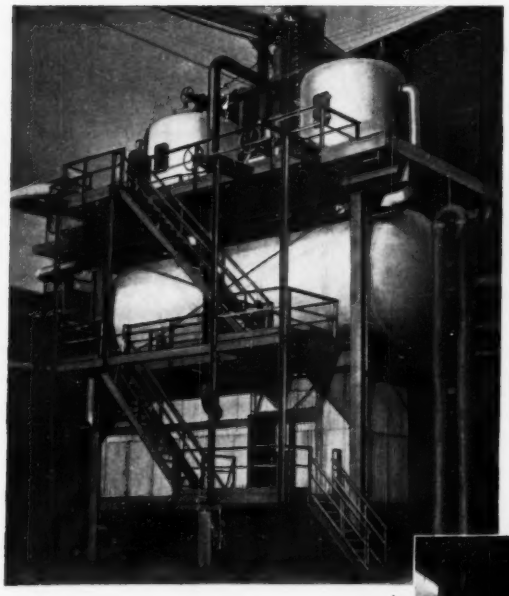

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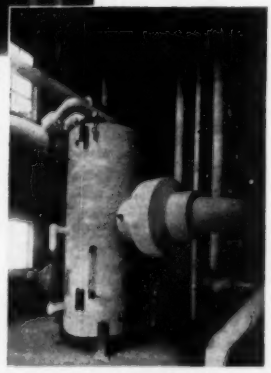
Standard designs of Graver small Deaerating Heaters are specially engineered for the same low-oxygen guarantee carried by the larger and more expensive Graver Heaters. These small Graver units provide complete deaeration at a low cost that is quickly returned by savings in plant operation, maintenance and outage costs.



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SK OIL BURNERS, GEAR PUMPS ASSURE CONSTANT BOILER PRESSURE

(Photos and story by courtesy of Stephen F. Whitman and Son, Inc.)

Candy manufacturing processes at WHITMAN'S Chocolates are highly mechanized. Constant boiler pressure must be maintained to operate the various processing equipment which controls the quality of WHITMAN'S fine candies.

Three boilers, each equipped with two burners are responsible for developing 375,000 pounds of steam per day at the company's Philadelphia plant.

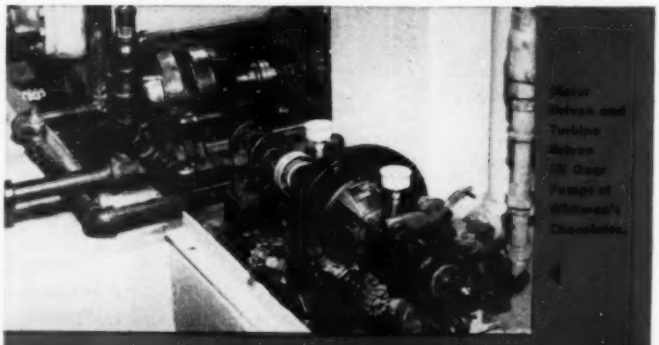
Boiler loads fluctuate widely, due to the complexity and operating demands of the processing equipment. With a minimum of effort, load fluctuations are easily met and boiler pressure held constant.

According to WHITMAN'S Plant Engineers, SK Oil Burners have the outstanding advantages of high efficiency, low maintenance and simple construction. These burners were installed in 1939. Since then, a minimum of maintenance has been required. The only parts replaced have been spirals, tips and goosenecks. Downtime has been negligible since these parts are easily and quickly replaced.

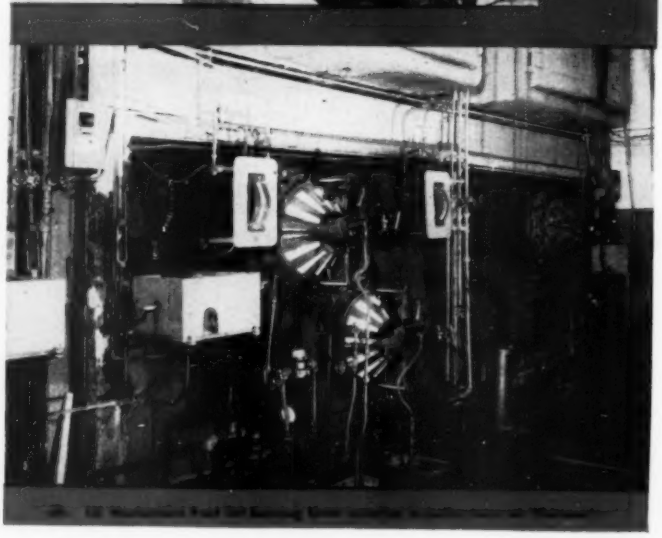
To insure a continuous flow of heavy fuel oil to the burners, a motor driven SK Gear Pump is used. Another SK motor driven pump and a steam turbine driven SK Gear Pump are utilized as standbys. The turbine driven unit is especially selected to protect operation in the event of electric power failure.

Highly viscous Bunker C Fuel Oil, preheated at 90° to 100° F., is pumped to the main oil heaters and thence to the burners at proper atomizing and burning temperature. WHITMAN'S engineers report that SK Gear Pumps have proved highly satisfactory in their plant because the pumps: (1) operate continuously; (2) pump oil at even pressures; (3) require a minimum of maintenance.

Bulletin 17-A covers — in detail — the wide range of Gear Pumps manufactured by SK. Complete information on SK Mechanical Fuel Oil Burning Systems is contained in Bulletin 16-A. Send for free copies.



Motor Driven and Turbine Driven SK Gear Pumps at Whitman's Chocolates.



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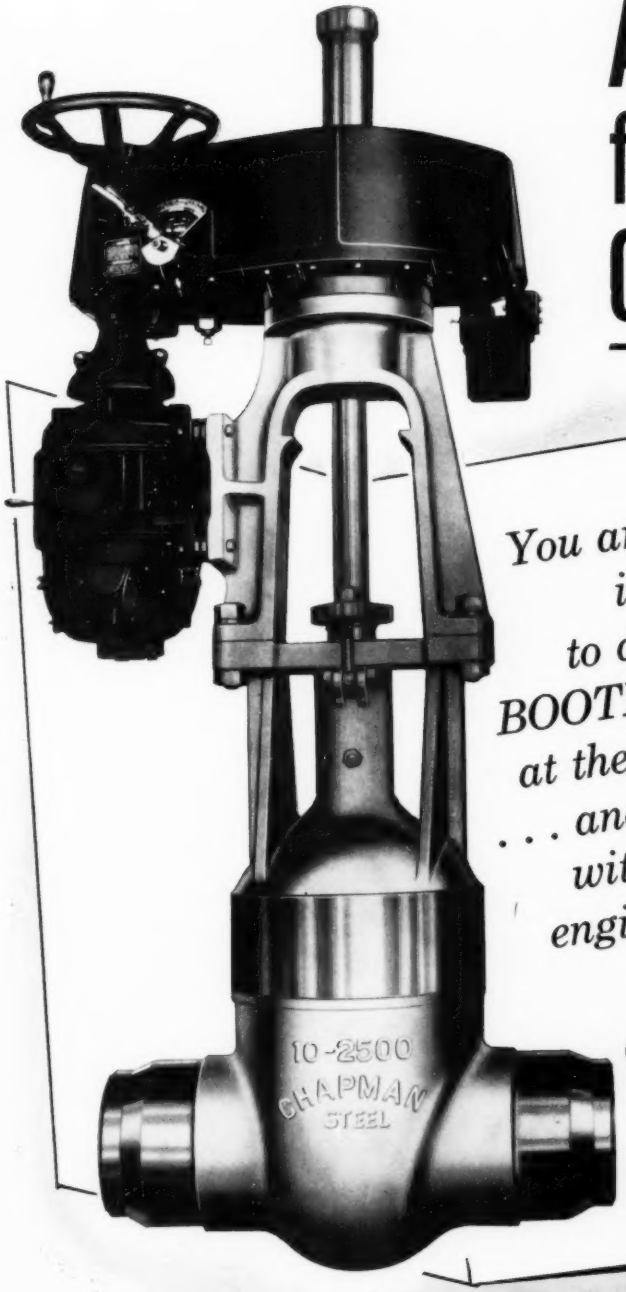
A Bid from Chapman



You are cordially invited to drop in at BOOTHS 46 and 47 at the Power Show . . . and to consult with sales and engineering staffs of The

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